ACTA RADIOLOGICA

EDITA PER SOCIETATES RADIOLOGICAS DANIÆ, FENNIÆ, HELVETIÆ, HOLLANDIÆ, NORVEGIÆ ET SUECIÆ

VOL. XII FASC. 6 31 : XII 1931 N:o 70

NOTRE MÉTHODE DE ROENTGENTHÉRAPIE DE LA LYMPHOGRANULOMATOSE (HODGKIN): RÉSULTATS ÉLOIGNÉS[1], *

par

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Depuis les travaux qui ont fait l'objet de notre communication[2] au Congrès international de Stockholm, en 1928, et de la thèse de l'un de nous,[3] travaux basés sur nos observations de 25 cas de granulomatose maligne (= G. M.), dont quinze traités par la méthode d'irradiation que nous préconisons, d'autres méthodes ont été proposées.

Des auteurs ont prôné, par exemple, la radiumthérapie. Nous ne voyons aucun inconvénient à substituer à la roentgenthérapie de la G. M. la gamma-thérapie, mais à condition qu'on possède de puissants foyers radioactifs et qu'on fasse véritablement de la télécuriethérapie, à des distances convenables. Cela suppose des quantités de radium importantes, et seuls de rares centres en sont pourvus à l'heure actuelle. Aux médecins qui ne sont pas équipés de la sorte, nous déconseillons formellement la curiethérapie, étant donné les larges surfaces à irradier et les intensités profondes requises pour traiter convenablement cette affection.

Comme nous le disions en 1928, la *roentgenthérapie* reste, à l'heure actuelle, faute d'un traitement causal, la *méthode de choix* dans le traitement de la G. M.

[1] *Communication* faite au IIIe Congrès International de Radiologie, Paris, juillet 1931.

[2] R. GILBERT. Le traitement de la granulomatose maligne par la roentgenthérapie pénétrante. *Acta radiologica*, vol. IX, fasc. 6, 1928, pp. 552—581, 22 fig. dont 4 planches hors-texte (édit. Norstedt et Söner, Stockholm).

[3] L. BABAIANTZ. *La granulomatose maligne.* Etude anatomo-clinique; étude thérapeutique spécialement du point de vue de la roentgenthérapie. *Thèse de Genève No 1258, 1928.* 176 pages, 16 fig. (a paru en librairie chez Payot, à Genève et à Paris).

* Remis à la Rédaction le 17. XI. 1931.

Mais dans le domaine de la roentgenthérapie, de nouvelles idées se sont fait jour:

C'est d'abord la méthode des irradiations de tout le corps, par téléroentgenthérapie, préconisée un temps par TESCHENDORF. Nous n'y insisterons pas, car nous croyons savoir que la méthode a été abandonnée par son auteur (réactions générales défavorables, malgré les petites doses administrées).

C'est, plus récemment, la méthode proposée par SLUYS, méthode d'irradiations du corps entier en champs séparés, sans distinction entre zones lésées et zones saines, avec étalement de la dose sur trois à quatre mois. Cette méthode est surtout basée sur la notion d'une atteinte générale du système réticulo-endothélial de l'économie, dans la G. M.

La méthode est trop récente pour qu'on puisse l'apprécier à sa juste valeur; qu'il nous soit cependant permis de faire »a priori» une objection: est-il possible, par cette méthode, d'arriver à donner une dose suffisante pour assurer la destruction des foyers granulomateux? Car nous savons par expérience que la guérison locale des volumineuses tumeurs ganglionnaires profondes (médiastin, par ex.) dont dépendent les rémissions durables, ne peut être obtenue qu'avec une concentration en profondeur, par feux croisés, de doses élevées, et données en un laps de temps relativement court. Ce postulat nous paraît difficilement compatible avec les irradiations de tout le corps telles qu'elles sont proposées par M. SLUYS, à moins de recourir à des doses difficilement tolérables.

Malgré notre objection, et sans préjuger les résultats éloignés que pourra nous apporter plus tard M. SLUYS, ainsi que les auteurs scandinaves qui travaillent dans cette direction, nous pensons que cette méthode peut trouver d'utiles indications dans certaines formes de généralisation ou de dissémination du processus.

Si les irradiations du corps entier nous paraissent contre-indiquées dans la majorité des cas, nous estimons d'autre part qu'il faut *condamner sévèrement les irradiations fragmentaires*, en quelque sorte symptômatiques et superficielles, encore trop souvent appliquées dans la G. M., ainsi que nous le constatons périodiquement.

Qu'il nous soit permis de rappeler, dans les grandes lignes, comment nous envisageons le traitement méthodique de la G. M.

Principe fondamental: Recourir à des doses suffisantes pour détruire les lésions granulomateuses dès la première série d'irradiations. A cet effet, concentrer tout l'effort sur les régions envahies par le processus et reconnaissables cliniquement (en évitant cependant de provoquer par des doses trop élevées une fonte brusque, rapide, des tissus granulomateux). Puis, étendre les irradiations, dans toute la mesure compatible avec la résistance de l'individu (contrôle sanguin), aux régions apparemment

saines, mais que l'expérience désigne comme fréquemment envahies par le processus.[1]

La réalisation de ce principe est subordonnée aux *règles suivantes:*

1. Le diagnostic étant posé (vérifié par biopsie), déterminer, après examen approfondi, tous les foyers cliniquement décelables, en s'aidant du radio-diagnostic.

Etablir un plan des irradiations, prévoyant d'abord l'irradiation large des régions cliniquement atteintes; en second lieu, l'irradiation des régions

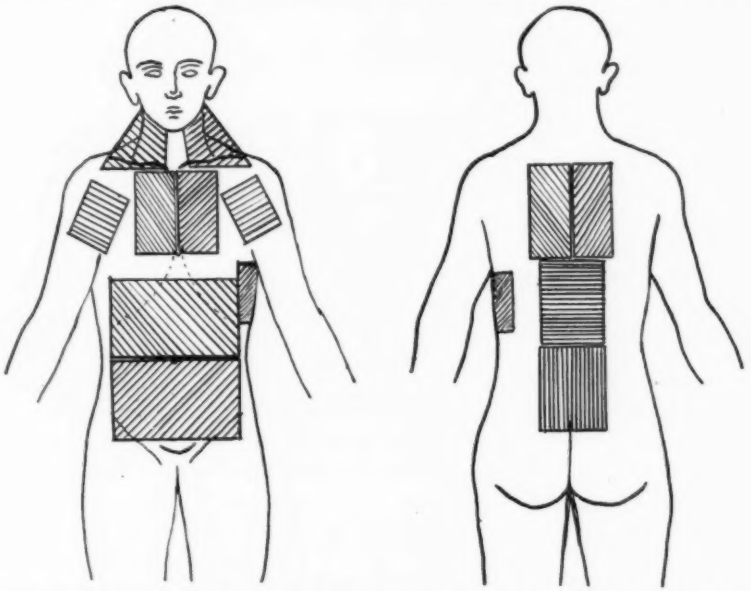


Fig. 1. *Schéma d'irradiations*, pour une forme cervicale et médiastinale, suspecte d'atteinte abdominale.

Noter que les deux champs indiqués à la partie externe du thorax sont en réalité des champs *axillaires*. Noter également que la multiplicité des champs impose un ajustement attentif des champs entre eux, pour obtenir l'homogénéité d'irradiations. (Ici les champs sont dessinés sans juxtaposition ni chevauchement, pour plus de clarté.)

simplement suspectes. (L'irradiation de ces dernières sera d'autant plus indiquée que persisteront des symptômes généraux tels que fièvre, prurit, etc.)

L'ordre des irradiations variera selon les formes cliniques et les localisations.

[1] N. B. — La leucopénie consécutive à la radiothérapie peut être tolérée jusqu'à une certaine limite: à notre avis on ne doit pas descendre au-dessous de 3,000 globules blancs, examen fait à jeûn.

Nous donnons ci-contre une idée *schématique* des régions que nous traitons dans la majorité des cas. (v. fig. 1.)

2. Nous résumerons les *conditions physiques et techniques* en deux mots: roentgenthérapie pénétrante.

Rayonnement émis, sous une tension de 180 à 200 kv., intensité de 2 à 4 mA, selon les appareils; filtration par 0,5 à 1 mm. de Cu et 1 mm. Al. Distances focales variables suivant la profondeur du foyer et les dimensions du champ à traiter.

3. *Posologie et chronologie:* la *dose profonde totale* que nous recommandons pour détruire, dans la majorité des cas, les tissus granulomateux, avec les moindres risques de récidive *in situ*, est, pour une première série d'irradiations, de 400 *r*.

Si nous nous exprimons, pour plus de précision, en doses incidentes, nous donnons habituellement, pour la première série d'irradiations:

a) pour les adénopathies relativement superficielles (cervicales, axillaires, etc), au total de 700—1100 *r*, selon le volume de l'adénopathie (généralement par un champ);

b) pour les tumeurs médiastinales (présentes dans la majorité de nos cas), *au total* env. 4,000 *r* concentrés par 4 larges portes d'entrée (soit 1,000 *r* par champ).

En présence de récidives, nous augmentons ces doses; et lorsqu'il s'agit d'atteintes viscérales (p. ex. pulmonaires), nous donnons, en feux croisés, la dose maxima compatible avec l'intégrité des téguments.

Sauf dans ce dernier cas, nos doses sont donc loin d'atteindre la limite de tolérance de la peau.

(Il va de soi qu'on devra individualiser. On élèvera ces doses moyennes, quand on se trouvera en présence de formes à prédominance scléreuse, réagissant cliniquement avec plus de lenteur; etc.)

Fractionnement des doses: nous donnons dans la règle 170 *r* par séance quotidienne ou bi-quotidienne. Nous ne pouvons entrer dans les détails, mais nous soulignerons ici qu'en cas de grosse tumeur granulomateuse (généralement très radiosensible) les fractions de dose quotidienne seront très inférieures, les premiers jours, de façon à éviter les phénomènes toxiques consécutifs à des résorptions massives.

Chronologie: étant donné *n* champs principaux, nous établissons un tour de rotation, jusqu'à administration de la dose totale à chacun d'eux.

L'étalement de la dose sur 10 à 15 jours pour chaque champ et la durée totale du traitement de 4 à 5 semaines, que nous avions indiqué comme normes, ne doivent pas être considérés comme rigides, notamment dans les cas où le processus est très étendu; mais il sera bon de s'astreindre à s'en éloigner le moins possible.

4. *Répétition* de la roentgenthérapie: Pas d'irradiations préventives, ou dites de consolidation, dans les cas où la première série d'irradiations paraît cliniquement suffisante. Attendre l'apparition d'une récidive. (Il faut persuader le malade de se présenter à des contrôles périodiques, mensuels d'abord, puis de plus en plus espacés.)

5. Nous conseillons, par contre, et nous nous en trouvons bien, la *cure arsenicale*, répétée à plus ou moins longs intervalles, en dehors des périodes d'irradiations; nous donnons aussi des toniques généraux. Nous avons observé en outre, depuis un certain temps, que le *régime végétarien* semble convenir particulièrement bien à cette catégorie de malades.

La cure arsenicale est un utile adjuvant: elle a fait ses preuves avant l'ère de la radiothérapie. Nous ne voudrions pas qu'on en conclût que l'arsenic joue un rôle de premier plan dans notre traitement: nous n'y avons recouru qu'après nous être assuré, dans nos premiers cas, que les résultats étaient bien dus essentiellement à la roentgenthérapie.

Résultats éloignés

Des quinze cas traités par notre méthode, onze étaient encore vivants en été 1928.

De ces onze cas, quatre sont décédés avant le printemps 1929, mais sept étaient encore vivants en avril 1931 (nous avons perdu une malade en juin).[1]

Les sept vivants (v. fig. 2) représentaient en avril une survie moyenne de *six ans* exactement, depuis le début de la roentgenthérapie. De ces sept cas, le plus ancien remonte à 1922 et le plus récent à janvier 1928 (soit trois ans et demi seulement). La durée moyenne de survie des six autres cas est en réalité supérieure, à ce jour, à *six ans et demi*.

De ces sept vivants sur quinze (tous biopsiés), deux cas se sont montrés particulièrement bénins: l'un d'eux remonte à 8 ans, mais l'autre à 4 ans seulement. Par contre, les 5 autres étaient des formes assez sérieuses et récidivantes.

Le cas n° 7, atteint d'une forme cervico-médiastinale a récidivé environ 8 ans après son unique traitement: début de généralisation. Il est actuellement rétabli depuis plusieurs mois.

Le n° 11 (adénopathies périphériques multiples à petits éléments), ancien T. B. C. pulmonaire fibreux, a commencé une poussée de T. B. C. évolutive (négligée) environ 6 ans après son unique traitement (il est maintenant dans sa septième année, sans récidive de G. M.).

Le n° 14, qui a fait des généralisations osseuses après une atteinte primitive périphérique et médiastinale, est dans sa septième année, sans récidive depuis plus de six ans.

[1] *Note au moment des corrections* (décembre): l'état des six survivants continue à être bon.

Le n° 16 (forme à prédominance cervico-médiastinale) a tenu un peu moins de six ans, mais avec 4 récidives depuis fin 1928 (c'est le cas qui vient de succomber aux suites d'un ictère par compression ganglionnaire des voies biliaires).

Le n° 25 (forme cervico-médiastinale) qui date de trois ans et demi, a fait une grave récidive abdominale dans la troisième année; cette malade est de nouveau florissante depuis plusieurs mois.

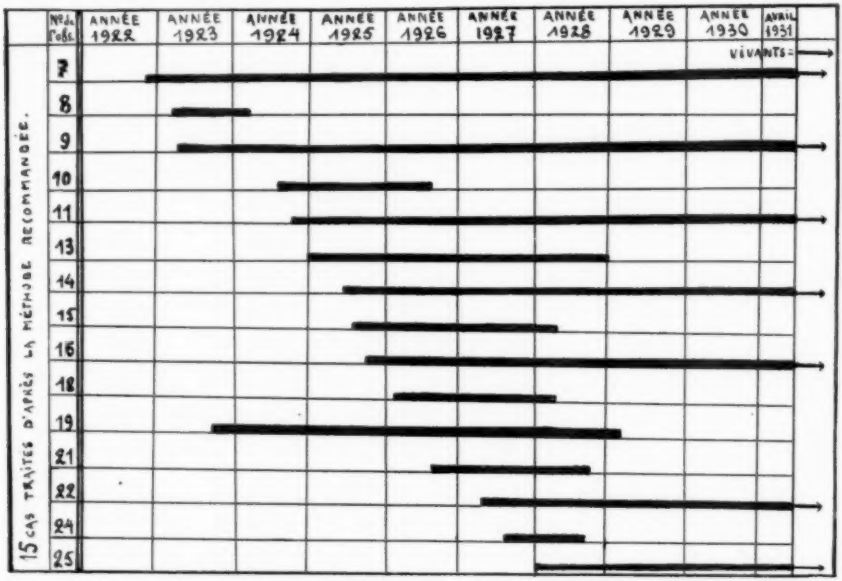


Fig. 2. Durée de survie, après le début de la roentgenthérapie, des quinze malades traités d'après la méthode recommandée.

Période d'observation: de 1922 à avril 1931.

Notons que tous ces malades ont retrouvé une santé équivalente à une guérison clinique, et une pleine capacité de travail (sauf, pour trois d'entre eux, pendant les périodes de récidive).

Etant donné le nombre de 15 malades dont nous faisons état, il est évidemment possible que nous ayons eu une série heureuse. Rappelons cependant que nous avions de très mauvais cas, dont deux ont évolué en moins d'un an depuis le début de la roentgenthérapie.

Si nous faisons le *bilan de nos quinze malades*, dont neuf sont morts actuellement, et six encore vivants, nous arrivons tout de même à une survie moyenne globale de *quatre ans et trois mois* depuis le début de la rœntgenthérapie.

Ce fait, et aussi les nouvelles méthodes préconisées depuis deux ans, nous ont engagés à revenir sur cette question en insistant sur le rôle que joue, à notre avis, la méthode d'irradiations.

RÉSUMÉ

Les auteurs passent en revue les méthodes de traitement radiologique proposées depuis trois ans. Ils rappellent les conclusions de leurs travaux antérieurs et la méthode recommandée par l'un d'eux dès 1925. Ils apportent leurs *résultats éloignés:* Des quinze cas de leur catégorie A (traités selon leurs idées) sept étaient vivants à fin d'avril 1931. Ces sept vivants représentaient, en avril, *une survie moyenne de six ans* depuis le début de la roentgenthérapie; depuis lors, un décès a été enregistré, et les quinze cas (dont neuf morts) donnent encore une survie moyenne *globale* de quatre ans et trois mois. La durée d'observation s'étale sur neuf ans.

SUMMARY

The authors review the various methods suggested during the last three years for the treatment of lymphogranulomatosis. They draw attention anew to the conclusions come to by them in their earlier communications, and to the method recommended by them as early as in 1925. They now communicate their *late results* as obtained by that method. Of the 15 cases comprised in their category »A» and treated according to their ideas, 7 were still alive at the end of April, 1931, representing at that time an *average survival of 6 years* from the time of instituted roentgen treatment. One of these seven has since died. The total 15 cases (of whom 9 have died) still represent a *total* average survival of 4 years and 3 months. The period of observation extends over 9 years.

ZUSAMMENFASSUNG

Die Verfasser referieren die seit drei Jahren vorgeschlagenen radiologischen Behandlungsmethoden und erinnern an die in ihren früheren Arbeiten gezogenen Schlüsse und an die von einem von ihnen seit 1925 empfohlene Methode. Sie legen ferner die *Spätresultate* bei 15 Fällen ihrer Kategorie A vor (die nach ihrer Methode behandelt worden waren); 7 waren Ende April 1931 am Leben. Diese sieben Lebenden repräsentierten im April eine durchschnittliche sechsjährige Dauer des Überlebens seit Beginn der Röntgenbehandlung. Seit Ende April 1931 ist ein Todesfall zu verzeichnen, und die fünfzehn Fälle (von welchen neun gestorben sind), ergeben *zusammengenommen* noch eine durchschnittliche Überlebenszeit von vier Jahren und drei Monaten. Die Beobachtungszeit erstreckte sich auf neun Jahre.

FROM THE ROENTGEN DEPARTMENT OF MARIA HOSPITAL, STOCKHOLM
(CHIEF: ÅKE ÅKERLUND, M. D.)

AN IMPROVED MODEL OF SERIAL FRAME[1]

by

Åke Åkerlund

It may perhaps seem unnecessary to add still further to the already numerous descriptions existing of different devices for serial radiography of the digestive tract, especially of the duodenum. Technical radiological literature of the last ten years has, as is well known, abounded in such more or less complicated descriptions of various »serial frames», that it might almost be said that every radiologist with a special interest in the duodenum has by now deviced his own »duodenal frame».

That nevertheless I am going to submit a brief description here of the last model of my duodenal frame, now more than 12 years old, is due to the fact that I have received several enquiries from abroad, particularly from American colleagues, as to its construction and use, and been asked repeatedly to give a brief account of it.

The serial frame[2] which is generally constructed for films 18×24 cm. in size is made entirely of metal. Its object is to enable one, after adjusting the picture by screening, to take four consecutive erect pictures on one and the same film. The serial frame (Fig. 1) consists of a rectangular lead screen, about 2 mm. thick, mounted in a metal frame provided with ledges. In the centre of the screen there is a rectangular window, the size of which is just one quarter of the size of the film (9×12 cm. for a film 18×24 cm.). The size of the frame is so proportioned that when one corner of the film casette is resting in one of the four corners of the frame, the diagonally opposite quarter of the film will occupy a position just in front of the window, ready for exposure. Between the exposures the film casette is displaced along the ledges of the metal frame; at each of the four corners of the frame an exposure is made.

The four pictures on each film will all be erect, two upper and two lower.

[1] Submitted for publication Oct. 27th, 1931.

[2] Manufactured by Järnhs Electric Company Ltd., Malmtorgsgatan 8, Stockholm.

After adjusting the picture under screening control the exposures are best commenced with the casette into one of the lower corners of the frame; in these two positions the casette is held against the window by a spring-flap. With the view to supporting the casette in the two upper positions the spring-flap is provided with a foot-plate which automatically slips into its place when the casette is lifted up from the lower exposure positions; the casette is further held firmly in these upper positions by broad metal rims along the borders of the frame.

The picture adjusted in the window can, if needed, be still further screened off by two lead diaphragms with rounded apertures which from either side can be pushed into the window.

The serial frame is above provided with an elevating handle, which is continued below into a broad tongue-shaped holder — facing the patient — for different diaphragmatic tubes and other compression devices. (Fig. 2.) The handle together with the tongue-shaped holder can be shifted along the upper border of the serial frame and can be secured in different positions by a spring-catch. This lateral adjustment is of importance in different oblique projections, as will be further dealt with below.

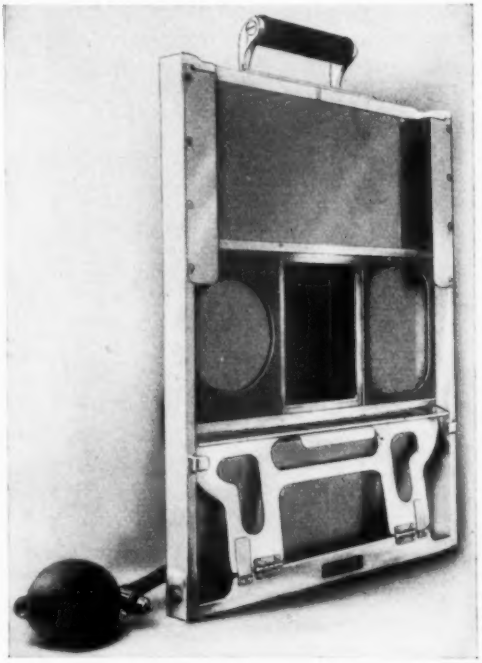


Fig. 1. The serial frame as seen from the observer's stand-point.

The tongue-shaped holder lends to the serial frame as a whole the form of a deep crutch whereby it can be readily hung up on the casette holder of every screening stand and thus obviate the risk of its subsequently falling down during the screening and causing injury to the patient or the observer.

Provision is made for a conical or cylindrical »Vorderblende», about 5 cm. in height, to be screwed down into the tongue-shaped holder (Fig. 3); to the cylindrical »Vorderblende» belong a few circular exchange-

able diaphragms of different sizes. When attached these tubes will occupy a place just in front of the centre of the window. Thanks to the above-mentioned lateral displacement of the tube holder one can always, even in the case of considerably oblique projections in relation to the serial frame, get the picture correctly centred in the window.

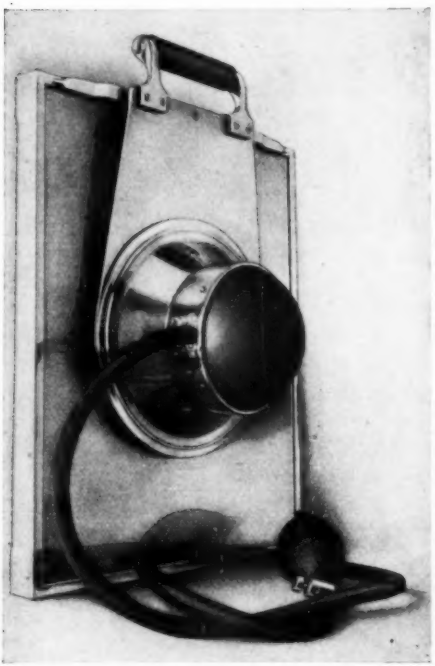


Fig. 2. The serial frame as seen from the patient's stand-point.

The conical »Vorderblende» is particularly suitable in all oblique projections. By the sides of the tube slanting about 45° with the axle of the tube the wall of the tube will not obscure the picture in oblique projections of up towards 45°, the picture being only limited by the front brim of the tube. By its tapered shape this diaphragm will cause very little inconvenience even to sensitive patients.

Both the cylindrical and the conical diaphragm may be provided with different compression caps, either in the form of aluminium cups or pneumatic rubber compressors attached through a lap to the brim of the tube facing the patient.

The pneumatic compressors are so constructed — their posterior walls being made of bakelit — that they are unable to expand backwards on being inflated. They are inflated by a rubber ball and provided with an exhaust valve conveniently accessible to the thumb of the same hand that holds the ball without the necessity of shifting the grip.

Naturally the serial frame can be used without either »Vorderblende» or compressors, but if once accustomed to the picture quality obtained by the aid of these accessory appliances, one will rather not be without them.

The pneumatic compressors particularly enable an easy and convenient dosage of the compression under screening control. In such cases where rubber compressors are not used the compression is regulated by the casette holder itself, carrying the serial frame, being pressed more

or less hard against the patient; for that purpose the casette holder is provided with an automatic catch device which at once secures it in any desired position of compression.

It is of very great advantage to have the rubber ball attached to the tube of the serial frame following all adjustments to which this is subjected as compared with CHAOUL's device with a compression belt attached to the patient, the rubber ball of which is much more troublesome to shift so that it always fits in with the varying projections.

On *using the serial frame* this is hooked on to the upper edge of the casette holder of the screening stand. The ordinary large well-pro-

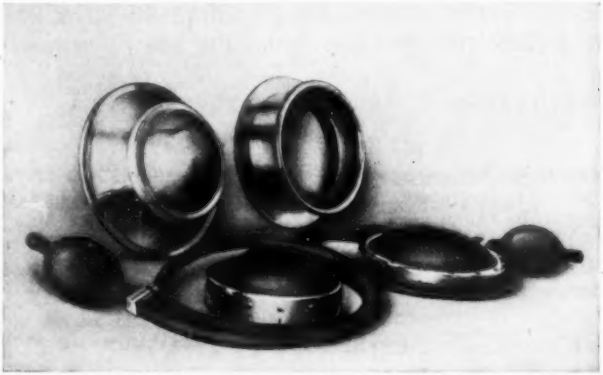


Fig. 3. Detachable conical and cylindrical tube (for compression, and absorption of secondary radiation) with appertinent aluminium- and rubber compressors.

tected fluorescent screen is used behind the serial frame for centring the picture in the window of the serial frame and for adjusting the dosage of the compression. The casette is then put into the frame and the exposures are conveniently commenced with the casette placed in one of the lower corners of the frame, continuing with the other lower corner and then going on to the two upper positions. On lifting up the casette the foot plate slips into its place automatically and thereby sustains the casette in the two upper positions.

The casette is shifted by hand between the exposures. The aim of this serial frame is not to enable the speediest possible exchange of films between the exposures, nor to enable some definite momentary phase of the varying screening picture to be caught on the film as in H. H. BERG's »gezielte Aufnahme». To my mind such pictures are only obtained at the expense of efficient protection against radiation; nor are they neces-

sary unless one wishes at any price to reduce the number of exposures to an absolute minimum.

If the compression is suitably dosed and the picture stands out well defined there is no need for any lightning target-practice; there is plenty of time to take four serial exposures without risking any appreciable alteration of the picture. For my own part I generally take the serial exposures at intervals of 1/4—1/2 minute with the view to obtaining different phases of the contraction. After shifting the casette there is plenty of time for the observer to retire to the protective cubicle during each exposure. If in certain delicate exceptional cases, as for example in the case of a duodenal niche observed during screening but not recovered in a well-adjusted serial picture, it will practically always reappear on the next picture provided the technique has otherwise been satisfactory.

SUMMARY

The author describes an improved model of his more than 12-year old serial frame for duodenal radiography. The serial frame is entirely of metal and enables 4 erect pictures to be taken on a 18×24 film. The serial frame may be provided with a conical or cylindrical »Vorderblende» and can also be used in very oblique projections. The compression effect of the tubes may be augmented, if needed, by cups of aluminium or hat-shaped rubber compressors.

ZUSAMMENFASSUNG

Verf. beschreibt ein verbessertes Modell seines mehr als 12 Jahre alten Duodenalserienrahmens. Der Wechselrahmen besteht ganz aus Metall und ermöglicht 4 Bilder in richtiger Stellung auf einem Film von 18 × 24 cm. Der Wechselrahmen kann mit einer konischen oder zylindrischen »Vorderblende» versehen und auch bei sehr schrägen Projektionen angewendet werden. Die Kompressionswirkung der Tuben wird bei Bedarf durch Aufsteckhülsen aus Aluminium oder hutförmigen Gummikompressoren verstärkt.

RÉSUMÉ

L'auteur décrit un modèle perfectionné de son sériographe duodénal, dont le premier modèle remonte à plus de 12 ans. Le sériographe est entièrement métallique et permet la prise de 4 images droites sur une pellicule 18 × 24. Ce châssis peut être muni d'une »Vorderblende» conique ou cylindrique et peut être utilisé dans des projections extrêmement obliques. L'effet de compression des tubes est, au besoin, renforcé par des cupules en aluminium ou par des compresseurs en caoutchouc.

FROM THE PHYSICAL LABORATORY OF RADIUMHEMMET, STOCKHOLM
(CHIEF: R. M. SIEVERT)

THE TIME FACTOR IN THE BIOLOGICAL ACTION OF X-RAYS[1]

I. Investigations on Drosophila Eggs

by

Rolf Sievert and *Arne Forssberg*

To acquire a more thorough knowledge of the influence of the physical factors in Curie and Roentgen therapeutics, it is essential to undertake extensive series of experiments on biological indicators of such a nature that statistically satisfactory results are obtainable. Naturally, the results of such investigations cannot simply be applied to the conditions prevailing, for instance, in treatment of malignant tumours. If only *one* object is tested, the result must be considered of insignificant value to medical research, even if the object, from a biological point of view, is closely related to cancer cells or normal tissue. If a certain biological testing object A_1, when exposed to radiation, shows any kind of conformity, that is to say that in this case some biological effect varies in a definite way, for instance as represented by a curve a_1, this will of course only entitle us to say that the testing material A_1 will react in this manner. If, however, another material A_2, biologically as far apart from A_1 as possible, gives a curve a_2 which is in any respect similar to a_1, we have reason to say that a law of more general applicability is conceivable. *Not unless the results of investigations of a great number of biological objects of widely differing nature are the same in principle, will it be probable that the results can be applied to the biological conditions governing Curie and Roentgen therapeutics.*

When choosing materials for the experiments, two factors in particular should be varied. Firstly, the cells of the several objects should have as different cell-division periods as possible, i. e. the time elapsing between the formation of one cell and the further subdivision of the same cell

[1] Submitted for publication Nov. 28th, 1931.

should vary within very wide limits for the several objects used. Secondly, it is essential that it be clearly established if the tendency indicated by the curves is independent of whether the whole organism or only part of it is tested, that is to say, the experiments must also be made on higher animals, on which local applications can be made. If all these experiments in any respect give cognate variations of the biological effect when a given physical factor is varied, then, and only then, is there reason to assume corresponding effects when applying radiation to tumours.

The question might be asked if it would not be simpler to examine the effect of radiation on animals of a comparatively high order only, e. g. rabbits or mice. It is, however, so very much more difficult to obtain appropriate indicators, and more particularly sufficient quantities for statistical purposes, among these than from biological objects of simpler structure, that the first experiments should be made on the latter kind, e. g. on low orders of animals or plants. If a certain degree of conformity is found in simple biological objects, the subject will become more familiar, and it will be much easier to ascertain if similar conformity is present when making tests upon animals of higher orders also, and to complete the chain of experiments which may enable us to translate our results into therapeutical practice.

A point which is as simple as it is important is generally overlooked when examining statistically how a biological effect varies with a certain physical factor. It is necessary to choose some minor, simple problem, and to isolate this, disregarding as far as possible all those problems which in the course of the experiments may invite further investigations. Obviously such biological variations as may cause errors must not be disregarded, but as soon as possible detached from the investigation in hand, and the problem treated from a purely statistical point of view. This is all the more important on account of the extensive material required in order to establish with any degree of certainty the presence of any biological conformity to laws. *The problems are to be treated by investigating the influence of one physical factor for many different biological objects, not to make a number of experiments on the same object.* As the latter is much simpler both as regards time and cost, irradiation investigations have generally been of that nature.

The present paper is presented as a modest beginning of a series of experiments on various biological objects, to ascertain the importance of the »time factor» to the effect of radium and X-rays. By »time factor» we mean how the biological effects vary if the same quantity of radiation is applied for varying times, that is, if the Bunsen-Roscoe law holds good for the biological effects of the radiation mentioned. The time factor in the case of the irradiation being divided into two or more periods (pro-

tracted fractional method of irradiation) does not, in one opinion, affect the problem directly. When this form of irradiation is used, the nature of the investigations must be regarded as being more exclusively biological, and in such cases it is generally very difficult to judge the results, owing to biological variations.

When the results of further experiments are published, it is our intention to collocate the literature on this subject and to compare our results with those reached by other investigators, and we therefore only point out here that several authors have obtained widely differing results with regard to the time factor. In a recent work, LIECHTI[1] has collected earlier researches in a table, which shows that the time factor, i. e. α in the formula $B = C \times I \times t^{\alpha}$, where B is the biological effect, I the radiation intensity, t the radiation time, and C a constant, by various authors and with different objects has been found to be < 1, as well as $= 1$ and > 1. Provided the dosages, from a physical point of view, have been unobjectionable, it would seem as though a biological difference in the time factor actually exists between the several objects. With few exceptions, these investigations are restricted to very small differences of intensity, generally 1:10 or 1:20, occasionally as high as 1:64.[2] It appears to us to be of interest to extend this range, and we have worked within the limits 2.8—4690 r per min., i. e. within a range of c. 1 : 1800, the shortest radiation exposures having been only about 2 seconds.

A priori it may be stated that if radiation of infinitely small intensity act during an infinite length of time, no biological action at all can be expected. If one and the same radiation quantity be given in different lengths of time (t), we consequently know that the curve of biological effect (B) must, for large values of t, asymptotically approach 0. At a certain value, B begins to rise fairly rapidly, and the form of the curve from this point to $t = 0$ shows the time factor for a given radiation quantity within that range of time in which a more distinct effect of the radiation can be observed. The time factor must in general be assumed to depend on the radiation quantity, i. e. the dose, which has often been overlooked, a circumstance which can possibly explain the varying results arrived at by the different investigators.

An essential in the investigation of the time factor is that the variation of radiation sensitivity in the biological object during the time when it is exposed to radiation is known. If this variation is continuously rising or falling, it will of course only be necessary to change the order of the small and large intensity irradiations in order to eliminate faults

[1] LIECHTI, A., Strahlentherapie, 33, p. 1, 1929.

[2] HOLTHUSEN, H., Strahlentherapie, 21, p. 275, 1926. Since our paper was written, GLOCKER, LANGENDORFF and REUSS (Strahlenther. 42, p. 148, 1931) have made investigations on Vicia Faba, varying the radiation time in the ratio 1 : 220.

from variable radiation sensitivity. But if it changes discontinuously or otherwise irregularly with the time, generally a thorough knowledge of the sensitivity-time-curve is required to be able to use that object for investigations of the time factor. If, however, the sensitivity oscillates at about the same value during the investigations, a usable statistical result is obtained if the period of the different cells are sufficiently regular, so that the mean sensitivity of the collection of irradiated cells can be considered constant. In such cases it is necessary to treat a great number of specimens in each seance. In many investigations sufficient consideration has not been given to this point.

A further circumstance which must be allowed for in experiments of this kind is that the radiation intensities used must be exactly determined. When large variations of intensity are used, it is often necessary to employ several different experimental devices combined with computations of the radiation intensity (radium!). Considerable errors may be caused by relying only on, for instance, the validity of the inverse square law, or on a technical measuring instrument which at great intensities may perhaps not be working with saturation current.

Biological part

As our first object we have chosen the eggs of Drosophila. On account of their rapid development, these are not a very suitable object for the experiments, but they have the advantage of being easily obtainable in large quantities, their development is particularly constant, and their culture requires very simple technical preparations. They are also very sensitive to radiation.

The procedure used here is to expose the eggs to X-rays of varying intensity, with subsequent determination of the death rate. The latter has proved very constant under given physical and biological conditions. As, in order to obtain distinct and commensurable results, it is important to treat the biological material uniformly, we will describe the procedure in detail.

PACKARD[1] has on several occasions described investigations of the effect of X-rays and also of γ-rays on the death rate of Drosophila eggs. He has found that the death rate is a very constant and sensitive indicator, and so reliable that he has even used it for dosimeter calibration. According to PACKARD, the division of the cells in this material is so rapid that in about 2 hours a 512-cell stage is reached, which is equivalent to

[1] PACKARD, CH., The Journal of Cancer Research, 10, p. 319, 1926, 11, p. 1, 1927, 11, p. 282, 1927, 14, p. 134, 1930, 14, p. 359, 1930.

a mean value of 10—15 minutes for each division. Under such circumstances it is not surprising that the sensitivity to radiation is very great. This, combined with the rapidly changing state of development of these eggs, excludes the use of anything but short exposures to radiation (max. c. 45 min.) for the purposes of our investigations.

PACKARD has made use of intensities between about 2 and 22 r per min., while changing both distance and milliampères. The experiments with varying mA, however, are of no use for our purposes, as information is lacking as to how tension and intensity were determined, and consequently the results cannot be properly judged.

Our stock of flies, of the *Florida* breed, was first inbred for several generations in order to get a homogeneous material. The flies were allowed to develop in a thermostat at 25° C., and the eggs were also placed in this immediately after exposure to radiation. The following nourishment was used, with some yeast added:

agar agar	12	gr
sugar	50	»
K-Na-tartrate	5	»
tartaric acid	3	»
$K H_2 PO_4$	0.6	»
$(NH_4)_2 SO_4$	1.2	»
$Mg SO_4$	0.3	»
$Ca Cl_2$	0.15	»
H_2O ad.	600	»

The many papers dealing with genetics give fuller details regarding the culture.

The eggs of the banana fly develop very rapidly; at 25° C. the development takes a time of c. 25 hours. Obviously, therefore, the age of the eggs when exposed to radiation is of great importance. The sensitivity varies with the age of the eggs. It is consequently desirable to obtain in a short period of time as many new-laid eggs as possible. But this requires a large stock of flies, and the work is rendered more difficult by the fact that the flies frequently do not lay their eggs immediately after fertilization. Nevertheless cell-division begins in these eggs.

PACKARD employs the following method. The flies are transferred straight from the stock culture to sheets of paper covered with nourishment solution. The first laid eggs, which may conceivably be too old, are rejected, and the flies are transferred to fresh solution. If a sufficient number of eggs is not obtained within a couple of hours, they are transferred to a third paper, and so on. In this way he obtains his material fresh. For our purposes, however, this method seems unnecessarily circumstantial, as we have found that very even results are obtained

if the flies are allowed to lay their eggs, all in the same jar, for 2 hours provided they have been well fed and that the nutritious substance has been frequently changed.

When we want the flies to lay their eggs for radiation purposes, they are transferred to glass cylinders, of the same shape as the jars, with a removable stopper in the bottom, on which a layer of nourishing solution (agar) about 1 cm thick has been deposited. When the stopper is unscrewed, the agar clot comes away intact, with the eggs embedded in the surface.

In 2 hours a very large number of eggs, between 3—400, are generally obtained. These eggs can be considered evenly distributed over the agar clot as regards age, as the flies lay promiscuously anywhere on the clot. Moreover the agar clot is then cut up into pieces holding c. 10 eggs each, and distributed arbitrarily among the samples exposed to the various radiation intensities investigated that day. At least 100 eggs are ordinarily used for each series. A portion of the eggs is used for control of normal hatching. A constant and steady hatching of c. 98 % having been observed, this control was in several instances dispensed with.

The order in which exposure to radiation is made, naturally varies from one experiment to another, to eliminate errors caused by the age of the eggs. For each radiation series, we use at least 2—4 forms of radiation, e. g. in the following order: 22 r/min — 198 r/min — 792 r/min — 1860 r/min — 22 r/min or 1860 r/min — 792 r/min — 198 r/min — 22 r/min — 1860 r/min. The difference in the death rate between the first and last radiation generally did not exceed 10 %, which provided a control that the sensitivity of the eggs had not been appreciably changed during the experiments. By experimenting on the same hatching with many different intensities, any »daily variations» in the eggs caused by differences in their average age at the beginning of the radiation — sometimes fairly large in spite of all precautions — were to some extent eliminated. As a matter of fact, an odd series may sometimes be far more instructive than the combined results of several. The following series, where the extremes of intensity were used, are given as instances of this.

I.	Int.	4690 r/min		5.5 r/min	4690 r/min
	Death rate	52.3		53.8	55.1
II.	Int.	4690 r/min	22 r/min	297 r/min	4690 r/min
	Death rate	51.2	52.1	49.6	52.2

The daily series usually show greater differences than these two cases do, often nearly 10 %.

Checking was undertaken in order to ascertain if electrical charging phenomena had any effect on the eggs and also if the fact that the secondary radiation, slightly changed with the size of the agar clots, could have any appreciable effect, in both cases with negative results. Secondary radiation from other sources was avoided by placing the agar clots on thin sheets of celluloid, suspended at various distances from the Roentgen tube.

Physical part

When investigating the significance of the time factor in the exposure of biological objects to radiation, the widest possible range of variability of the radiation intensity, without any qualitative change in the rays, is essential. This can be attained in two ways. The milliampère may be changed without altering the voltage applied to the X-ray tube, or the object exposed to radiation may be placed at varying distances from the focus of the tube. From the physical point of view, the former way is reliable, provided the voltage curve of the high voltage generator does not change with the load, which must be considered to be at least approximately the case when using constant voltage apparatuses. The latter way can only be used if the radiation intensity can be determined with sufficient exactitude, as it is not advisable to assume it to diminish with the square of the distance when the distances used are small. Secondary radiation from the filter placed between the tube and the object, and even from dazzle screens and other objects in the beam, may cause deviations from the inverse square law. Further, the source of the rays cannot always be considered as a radiating point, because the X-rays are not exclusively emitted from the focal spot.

The arrangement used in the experiments here described consisted of a Siemens Stabilivolt apparatus (constant voltage) of modern design, and a Müller Metwa-Metallix tube with ordinary thermosiphone water-cooling for a maximum of 4 mA. This latter proved very suitable for the experiments, as the compact design on the one hand makes it possible to regard all the rays as coming from the same point, even if primary and secondary radiation from other parts of the tube than the focus be considered, and on the other, permits radiation at very short distances. When large intensities were desired, the milliampère was raised for the short duration of the radiation to 6, 8 or 10 mA, an overload apparently harmless to the tube.

To obtain sufficiently large intensities, a filter of only 1 mm aluminium was used, with variations of milliampères as well as of distance, according to the following table.

Table I

No.	Intensity r/min	Distance	mA	No.	Intensity r/min	Distance	mA
1	2.8	85	1	12	792	12.3	6
2	5.5	60	1	13	1240	9.8	6
3	22	60	4	14	»	8	4
4	49.5	40	4	15	1860	9.3	8
5	»	20	1	16	»	8	6
6	88	30	4	17	2810	6.5	6
7	198	20	4	18	»	8.4	10
8	297	20	6	19	3750	6.5	8
9	»	16.3	4	20	»	7.2	10
10	»	11	1	21	4690	6.5	10
11	792	10	4				

The fact that identical intensity variations were on several occasions obtained both by reducing the distance and by increasing the current through the X-ray tube, provided an indirect control of the physical dosage.

The following series are quoted as examples of experiments with the same dose and intensity, obtained by variation of mA and distance:

Table II

Intensity r/min	Dose	mA	Distance	Number of experiments	Number of eggs	Death rate
49.5	83	4	40	3	268	20.5
»	»	1	20	3	448	25.0
»	110	4	40	4	572	37.1
»	»	1	20	3	491	30.2
»	165	4	40	5	841	52.2
»	»	1	20	6	1022	51.0
»	220	4	40	4	840	71.5
»	»	1	20	4	744	74.8
297	165	6	20	1	212	49.1
»	»	4	16.3	1	222	50.5
»	»	1	11	1	186	47.9
1240	»	6	9.8	2	236	50.4
»	»	4	8	2	241	52.7
1860	»	8	9.3	3	277	53.1
»	»	6	8	3	354	54.8
2810	»	10	8.4	1	186	48.9
»	»	6	6.5	2	296	53.0
3750	»	10	7.2	1	194	52.1
»	»	8	6.5	1	221	54.8

The death rates observed when applying the same dose at varying mA and distance show no regular changes of any kind, which also indicates that the physical conditions were satisfactory.

At the various loads employed (2—10 mA, 170 kV) the voltage was determined by means of the ABRAHAM-VILLARD electrostatic kilovolt-

meter, and proved constant within ± 2 % when the correction table for the ordinary voltmeter on the primary side of the transformer, which accompanied the X-ray machine, was followed.

The determination of the intensity in r per min. was made at a distance of 50 cm by means of the portable secondary standard apparatus of the Laboratory, which had recently been calibrated with the assistance of a newly designed large standard chamber. The values given in the table were then checked by means of two ionization instruments of the kind earlier described in this journal.[1] The inverse square law proved valid for large distances.

For short distances (less than 15 cm from focus to object) a special device was designed whereby relative intensity determinations could be made down to 6.5 cm from focus.

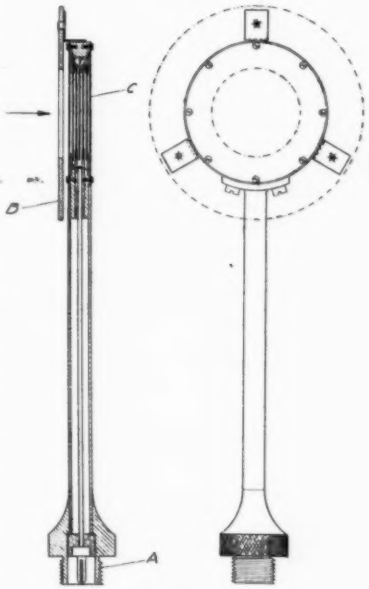


Fig. 1.

The ionization chamber (see fig. 1) consisted of a cylindrical aluminium box, 60 mm in diameter and of 6—8 mm effective height. Inside this box, 3 plates of ordinary telephone membrane (carbon) were placed, joined in the manner shown in the illustration. The distances between the surfaces of the plates were c. 1 mm. On top of the box, lead screens of different sizes could be fitted to obtain suitable measuring ranges for different intensities. As the device was only used for very large radiation intensities, the ionization current could without difficulty be determined by means of an ordinary galvanometer (Deprez d'Arsonval) with a sensitivity of c. $5 \cdot 10^{-10}$ ampère per scale division at 1.5 m scale distance. The ionization chamber was thus connected in series with a galvanometer and two anode batteries of 180 volt. One terminal of the battery was connected to a protective casing surrounding the whole measuring device.

The following Table contains the results of intensity-determinations with various screens. The last column shows that no deviation from the inverse square law could be traced, at any rate not within ± 5 %.

[1] SIEVERT, R. M., Acta Radiologica, 5, p. 468, 1926.

Table III

Distance a	Ionization I	Dazzle screen d^2 in cm^2	$\frac{a^2 I}{d^2}$	Distance a	Ionization I	Dazzle screen d^2 in cm^2	$\frac{a^2 I}{d^2}$
5.90	1.40	4	1.22	8.81	1.46	9	1.26
6.09	1.36	»	1.26	10.02	1.14	»	1.27
6.20	1.32	»	1.27	8.63	2.77	16	1.29
6.34	1.25	»	1.26	9.55	2.24	»	1.28
6.71	1.16	»	1.31	11.13	1.69	»	1.31
7.01	1.06	»	1.30	12.19	1.40	»	1.30
6.99	2.27	9	1.24	13.34	1.16	»	1.29
7.82	1.81	»	1.23	14.98	0.91	»	1.28

For short times of exposure (less than 20 secs.), a special shutter had to be used for the satisfactory protection of the eggs from radiation while the X-ray apparatus was adjusted to correct voltage and milliampère. For this purpose a photographic sector shutter with $^1/_2$ mm gold plate sectors was used. Exposures of photographic plates proved this protection to be sufficient. Some series of radiation with the shutter closed and very large radiation quantities (6000 r) indicated that for the greatest intensities a correction of up to 5 % had to be applied. An automatic time release, consisting of a clockwork controlled by a stop watch, was used.

Results of investigations

In order that the reader shall be able to judge correctly the result of an investigation, it is in our opinion absolutely essential that the primary experiments should be published. Most papers on this subject give only a summary of the results, from which it is impossible to decide how far one can draw definite conclusions. Moreover, when experimenting on biological objects, information is seldom given as to the probable experimental error, so that the value of the results to the reader will depend almost entirely on his opinion of the author's judgement.

The results of all the irradiations carried out with the dose 165 r are therefore collocated in the following table.

Table IV.

(n = number of investigations)

Date	Number according to table I	Intensity r/min	Number of eggs (N)	Death rate % (D)	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma N \cdot D}{\Sigma N}$
23. 8. 31	1	2.8	114	40.6			
27. 8. »	»	»	241	37.8	40.1		40.1
12. 9. »	»	»	253	42.0			$\Sigma N = 608$

Date	Number according to table I	Intensity r/min	Number of eggs (N)	Death rate % (D)	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma N \cdot D}{\Sigma N}$
27. 5. 30	2	5.5	51	59.0			
7. 6. »	»	»	135	62.0	59.4		
15. 6. »	»	»	175	58.0			
25. 6. »	»	»	85	58.8		55.8	54.6
25. 6. 30	2	5.5	297	50.5		n = 8	ΣN = 1 186
26. 11. »	»	»	162	51.3	52.0		
20. 5. 31	»	»	150	53.8			
23. 5. »	»	»	131	52.4			
4. 6. 30	3	22	52	50.0			
5. 6. »	»	»	82	56.0			
6. 6. »	»	»	32	59.4			
6. 6. »	»	»	25	56.0			
7. 6. »	»	»	51	64.7	55.9		
9. 6. »	»	»	138	50.4			
13. 6. »	»	»	251	57.4			
15. 6. »	»	»	110	58.0			
27. 6. »	»	»	93	51.6		53.8	53.3
29. 6. 30	3	22	139	51.1		n = 19	ΣN = 2 340
29. 6. »	»	»	146	51.4			
22. 2. 31	»	»	129	49.6			
6. 3. »	»	»	161	57.7			
12. 3. »	»	»	113	50.4	52.4		
12. 3. »	»	»	121	48.0			
10. 5. »	»	»	99	54.5			
16. 5. »	»	»	284	52.1			
22. 4. »	»	»	198	54.0			
	»	»	116	50.1			
13. 6. 30	5	49.5	89	54.0			
13. 6. »	»	»	249	57.0			
15. 6. »	4	»	236	52.2			
15. 6. »	5	»	229	48.5	52.3		
25. 6. »	4	»	104	53.8			
25. 6. »	»	»	249	55.9			
27. 6. »	»	»	82	50.0			
29. 6. 31	»	»	170	47.1		50.8	51.3
29. 6. 31	5	49.5	183	48.6		n = 16	ΣN = 2 141
29. 6. »	»	»	171	49.8			
26. 11. »	»	»	101	45.5			
1. 3. »	4	»	67	44.7	49.6		
4. 3. »	»	»	58	55.0			
4. 3. »	»	»	60	53.4			
4. 3. »	»	»	26	53.8			
13. 3. »	»	»	67	46.3			
9. 6. 30	6	88	92	62.0			
13. 6. »	»	»	434	58.7	58.1		
19. 2. 31	»	»	149	59.2			
18. 3. »	»	»	141	52.5		54.7	55.3
18. 3. 31	6	88	126	53.2		n = 9	ΣN = 1 497
18. 3. »	»	»	157	51.6			
22. 3. »	»	»	141	51.8	52.1		
22. 3. »	»	»	115	53.9			
22. 3. »	»	»	142	50.0			

Date	Number according to table I	Intensity r/min	Number of eggs (N)	Death rate % (D)	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma N \cdot D}{\Sigma N}$
13. 6. 30	7	198	94	56.4			
13. 6. »	»	»	322	59.0			
15. 6. »	»	»	183	54.7	56.3		
25. 6. »	»	»	216	57.4			
25. 6. »	»	»	111	53.8		53.6 n = 10	54.1 ΣN = 1 644
27. 6. 30	7	198	127	55.9			
27. 6. »	»	»	96	49.0			
29. 6. »	»	»	219	47.0	50.5		
29. 6. »	»	»	137	53.3			
6. 3. 31	»	»	139	49.7			
26. 4. 30	8	297	185	47.0			
22. 3. 31	»	»	106	49.1	48.9		
22. 3. »	»	»	212	50.5		48.8 n = 6	48.8 ΣN = 1 022
22. 3. 31	10	297	186	47.9			
22. 3. »	9	»	222	49.1	48.8		
16. 5. »	8	»	111	49.6			
19. 2. 31	11	792	90	58.8	52.1		
8. 3. »	»	»	79	45.5		50.8 n = 4	50.9 ΣN = 363
12. 3. 31	11	792	95	48.4	49.5		
18. 3. »	12	»	99	50.5			
19. 2. 31	14	1240	167	57.0			
19. 2. »	»	»	173	59.5			
22. 2. »	»	»	121	53.0	52.7		
8. 3. »	»	»	71	46.5			
12. 3. »	»	»	152	47.4		53.1 n = 10	53.6 ΣN = 1 267
18. 3. 31	14	1240	106	61.3			
10. 4. »	13	»	97	50.0			
10. 4. »	14	»	103	50.5	53.5		
12. 4. »	13	»	139	51.1			
12. 4. »	14	»	138	54.4			
4. 3. 31	16	1860	104	49.0			
4. 3. »	»	»	76	57.0			
4. 3. »	»	»	35	51.4	55.2		
3. 3. »	»	»	53	64.1			
10. 4. »	15	»	112	53.6			
10. 4. »	16	»	146	56.2		54.1 n = 12	52.9 ΣN = 1 182
12. 4. 31	15	1860	86	53.5			
12. 4. »	»	»	79	52.0			
12. 4. »	16	»	110	57.3	53.0		
12. 4. »	»	»	98	50.0			
12. 4. »	15	»	167	52.1			
22. 4. »	16	»	96	53.1			
1. 3. 31	17	2810	77	53.3			
1. 3. »	»	»	26	46.2			
4. 3. »	»	»	75	46.6	50.5		
4. 3. »	»	»	105	53.3			
4. 3. »	»	»	48	50.0		50.3 n = 12	50.9 ΣN = 1 181
6. 3. »	»	»	77	53.3			

Date	Number according to table I	Intensity r/min	Number of eggs (N)	Death rate % (D)	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma D}{n}$	Mean $\frac{\Sigma N \cdot D}{\Sigma N}$
8. 3. 31	17	2810	88	46.5			
12. 3. »	»	»	107	46.8			
22. 3. »	»	»	96	55.2	50.1		
10. 4. »	»	»	93	48.4			
13. 4. »	18	»	186	48.9			
13. 4. »	17	»	203	55.1			
18. 3. 31	19	3750	119	53.8			
18. 3. »	»	»	108	56.5	55.5		
18. 3. »	»	»	139	56.1		54.2	54.2
22. 3. 31	19	3750	73	52.0		n = 6	ΣN = 854
13. 4. »	»	»	221	54.8	53.0		
13. 4. »	»	»	194	52.1			
10. 5. 31	21	4690	75	54.6			
10. 5. »	»	»	88	51.2	52.3		
16. 5. »	»	»	86	51.2			
16. 5. »	»	»	134	52.2		53.3	53.3
20. 5. 31	21	4690	127	52.3		n = 8	ΣN = 864
20. 5. »	»	»	143	55.1	54.3		
23. 5. »	»	»	93	56.2			
23. 5. »	»	»	118	53.6			

In agreement with PACKARD, we have found that with radiation intensities below about 5 r/min, the death rate diminishes rapidly. As has already been pointed out, however, these small intensities, which make it necessary to work with comparatively long irradiation times, are not suitable for investigations of the time factor, because of the rapid development of the eggs.

According to our results, from which table V has been collocated, the time factor, when applying greater intensities, is equal to 1. With 165 r

Table V.

r/min	Death rate			
	83 r	110 r	165 r	220 r
2.8	8.6	10.0	40.1	49.2
5.5	20.3	33.6	54.8	72.5
22	21.2	33.0	53.7	73.3
49.5	23.4	33.8	52.2	73.0
88	21.6	37.7	55.3	70.1
198	23.7	38.3	55.6	70.9
297			48.8	
792			50.9	
1240		31.3	53.1	
1860	22.5	35.2	53.9	69.0
2810			50.9	
3750			54.2	
4690			53.2	

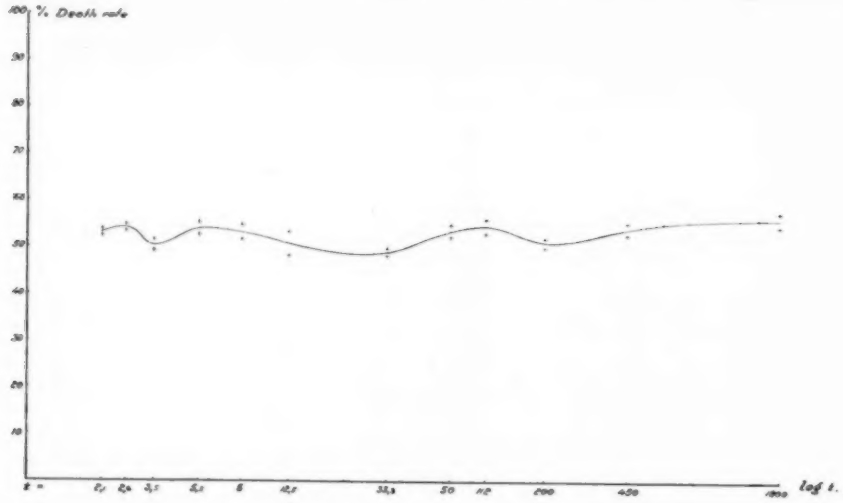


Fig. 2. Dose 165 r.

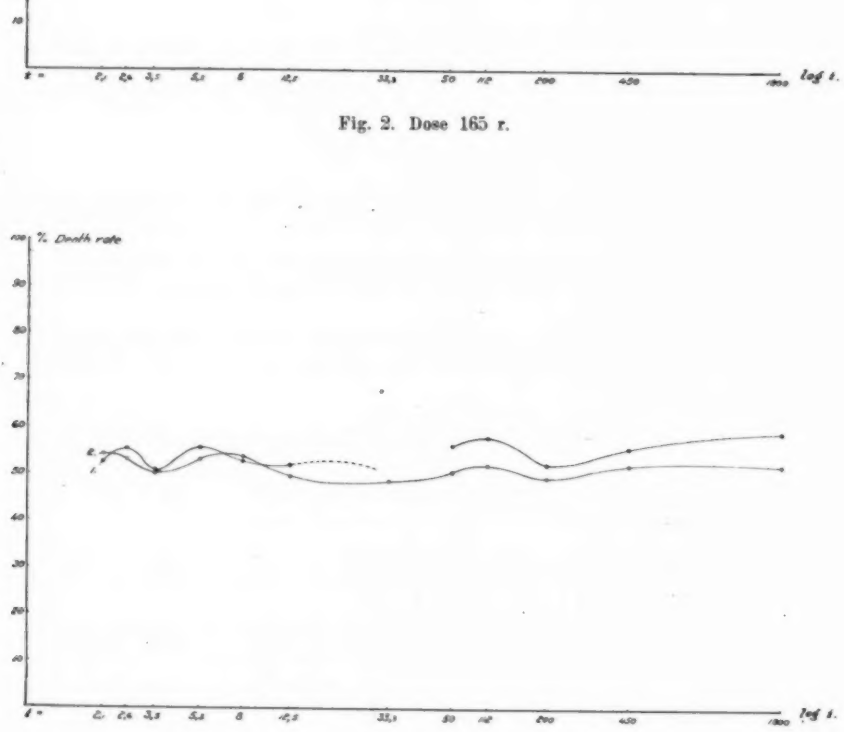


Fig. 3. Dose 165 r.

we get a death rate of about 50 per cent, and with this dosage we have made a large number of tests under very varying conditions down to the whole dose being given in 2.1 seconds. The time intervals between which the time factor has been investigated are given in the following table.

Table VI.

Dosage	83 r	100 r	165 r	220 r
Interval	5.0—3600	3.3—3600	2.1—3600	6.7—3600

The investigations show that the death rate is the same if the dose 165 r is applied in any length of time between 2.1 and 1800 secs. It is astonishing that the eggs react as they do for such extremely short irradiations, and later on we shall try to make tests with still shorter times.

In the diagram in fig. 2 the death rate obtained with this dose is plotted against the logarithm of the radiation time. The mean values of all the investigations supply the curve in that diagram, in which the mean errors of these values are plotted. The curve shows irregularities which look like undulations with the time. When dividing the investigations into two groups according to their chronological position (c. f. Table IV) we find the same periodical changes as are to be seen in fig. 3. It is difficult to judge the reason of these periods. Perhaps they are caused by the divisions of the cells which probably take place at varying intervals. During the mitoses the cells may be much more sensitive to radiation than in the meantime, and therefore, when the irradiation times just cover a certain number of successive mitoses, a higher death rate must be expected. One must also assume that though the cells or eggs are equally divided among all stages of development, this point of view may be of importance.

SUMMARY

Researches into the time factor are discussed in general. The authors point out the necessity of making a great number of investigations with biological objects of a widely differing nature, if results usable in radium and Roentgen therapy are to be expected. The time factor when treating with protracted fractional irradiations is very complicated. The problems of the time factor by one single irradiation must first be solved.

The present paper is a modest beginning of considering the time factor, especially when working with short irradiation times. Drosophila eggs have been irradiated with 83—220 r with varying intensities of X-rays, the exposures varying from 3600 to 2.1 seconds. With the aid of several measuring instruments the irradiation intensities have been controlled down to a distance of

6.5 cm from the target of the X-ray tube. The results can be collocated as follows.

The death rate of the eggs of Drosophila is on the whole affected equally if the irradiation dose of 165 r is given for any time whatsoever between 2.1 seconds and 1800 seconds.

The same result is obtained also when using larger and smaller doses, at least in the region of 83—220 r in times exceeding 5—10 seconds.

With intensities of less than about 5 r per minute the death rate drops very rapidly, in agreement with researches carried out by PACKARD.

An undulating curve is obtained when plotting the death rate against the time which is imagined as occurring if every egg periodically passes through stages of increased sensitivity irradiation.

ZUSAMMENFASSUNG

Untersuchungen über den Zeitfaktor werden eine allgemeine Diskussion unterzogen. Die Verfasser weisen auf die Notwendigkeit der Durchführung einer sehr grossen Anzahl Untersuchungen an biologischen Objekten verschiedenster Art hin, um Ergebnisse, die in der Radium- und Röntgentherapie verwendet werden können, zu erzielen. Das Problem des Zeitfaktors ist bei der Behandlung mit verzettelten Dosen sehr kompliziert. Das Problem des Zeitfaktors bei einer einzigen Bestrahlung muss vorerst gelöst werden.

Vorstehender Artikel ist ein anspruchsloser Anfang zur Untersuchung des Zeitfaktors, besonders bei Verwendung kurzer Bestrahlungszeiten. Drosophilaeier sind mit 83—220 r bestrahlt worden, wobei die Exponierungszeit je nach der Intensität der Röntgenstrahlung innerhalb eines Intervalls von 3,600 bis 2.1 sek. variierte. Mit Hilfe verschiedener Messinstrumente sind die Strahlungsintensitäten bis herunter auf 6.5 cm Röntgenröhren-Anodenabstand kontrolliert worden. Die Resultate können wie folgt zusammengefasst werden:

Im ganzen genommen ist der Sterblichkeitsprozent der Drosophilaeier bei einer Bestrahlungsdosis von 165 r und einer beliebigen Zeit zwischen 2.1 und 1,800 sek. der gleiche.

Dasselbe Resultat erhält man bei grösseren und kleineren Dosen, wenigstens innerhalb des Gebietes 83—220 r und bei längeren Zeiten als 5—10 sek.

Bei Intensitäten von weniger als circa 5 r pro Min. sinkt die Sterblichkeit sehr schnell, in Übereinstimmung mit den von PACKARD gemachten Untersuchungen.

Eine wellenförmige Kurve erhält man, wenn man die Sterblichkeit als Funktion der Bestrahlungszeit aufzeichnet, was möglicherweise darauf zurückgeführt werden kann, dass jedes Ei periodisch Stadien erhöhter Empfindlichkeit für Bestrahlung durchläuft.

RÉSUMÉ

Les recherches sur le facteur de temps font l'objet d'une discussion générale. Les auteurs soulignent la nécessité de faire de nombreuses expériences sur des sujets d'ordres très différents pour obtenir des résultats utilisables en radiumthérapie et dans les Rayons X. Le problème du facteur de temps est très compliqué lors de traitements comportant l'application fractionnée des rayons. Le pro-

blème du facteur de temps, lors d'une seule application de rayons, doit être résolu en premier lieu.

L'article qui va suivre n'est qu'un modeste début de l'étude du facteur de temps, particulièrement en ce qui concerne les travaux comportant de courtes applications des rayons. Des œufs de Drosophila ont été soumis à des rayons de 83 r à 220 r, la durée d'exposition a varié, selon l'intensité des Rayons X, entre 3,600 et 2.1 secondes. A l'aide de différents instruments de mesure, l'intensité des rayons a été contrôlée jusqu'à une distance de 6.5 cm de l'anode du tube de Roentgen. Les résultats enregistrés peuvent se résumer comme il suit:

Le pourcentage de mortalité des œufs de Drosophila est, dans l'ensemble, le même lors d'une application de rayons de 165 r pendant une durée quelconque, variant entre 2.1 et 1,800 secondes.

On arrive également au même résultat en appliquant des doses plus ou moins fortes au moins dans les limites de 83 à 220 r et pendant des durées dépassant 5 à 10 secondes.

Pour des intensités inférieures à environ 5 r par minute, la mortalité des œufs diminue très rapidement conformément aux expériences réalisées par PACKARD.

On obtient une courbe ondulante en faisant le diagramme de la mortalité en fonction de la durée d'application des rayons, ce qui peut s'expliquer par ce que chaque œuf traverse périodiquement des phases de sensibilité accrue par rapport à l'action des rayons.

(FROM THE ROENTGEN INSTITUTE, SERAFIMER HOSPITAL, STOCKHOLM, SWEDEN.
HEAD: PROFESSOR G. FORSSELL.)

ON METEORISM IN PYELOGRAPHY AND ON THE PASSAGE OF GAS THROUGH THE SMALL INTESTINE[1]

by

W. Magnusson

(Tabulæ LII—LIV)

Gas in the intestines often hampers the roentgen examination of the urinary and biliary tracts, pelvis and lumbar spine. The measures suggested for the elimination of this gas vary considerably in their effect. HAUDEK and SGALITZER (1) even state (1926) that as a rule they take no preliminary measures in their roentgen examination of the urinary tracts. In pyelography considerable meteorism is strikingly common although the patients here are prepared in the same way as in other examinations of the urinary tract. The abundant accumulation of gas often renders the interpretation of the radiograms more difficult and it has therefore seemed to me of interest trying to ascertain the cause of this form of meteorism and, if possible, finding some means of its prevention.

As a preliminary measure in the roentgen examination of the urinary tract we gave the patient as an aperiant 2 table-spoonfuls of castor oil in the morning of the day preceding the examination. On that day the patient was only given fluids by mouth. In the morning of the day of examination an enema was given and the patient was then examined on fasting stomach. Before passing the ureteral catheters we have as a rule taken surveying pictures of the urinary tracts after which cystoscopy and ureteral catheterization has been done soonest possible and the pyelograms taken some hour or so later.

On comparing the surveying pictures and the pyelograms it was often found that the main bulk of gas had arisen in the intervening time, i. e. in 1—2 hours. — On the pyelograms a strikingly great amount of gas was as a rule observed in the stomach, sometimes causing this to be greatly distended. Small quantities of gas could generally be seen here and there in the small intestine. — In several cases it was found on pyelo-

[1] Submitted for publication Dec. 19th, 1931.

grams that had been taken at intervals of about 10 minutes that a considerable amount of gas (about $^1/_2$ litre) had collected in the stomach in that space of time (fig. 1). These observations proved of great importance for forming an opinion on the origin of the gas.

Intestinal gases arise 1) from chemical processes of decomposition of the contents of the digestive tract, 2) from the blood from where gas may be given off and 3) from swallowing of air.

Gas formation through chemical decomposition takes place partly in the stomach after ingestion of alkaline food-stuffs (e. g. effervescent drinks), partly in the small intestine where CO_2 is formed by carbonates of the intestinal juices on neutralization of the acid chyme from the stomach (v. BUNGE quoted from R. SCHOEN 2), partly also in the colon through processes of fermentation and decomposition. A large proportion of the gas formed by chemical decomposition is absorbed and given off with the expiratory air. This is the case above all with the CO_2. —CH_4 and to a less extent also H_2 are absorbed, especially when escape of flatus is hindered (foetor ex ore). — In the cases under review the patients were examined on fasting stomach. No greater import can therefore be attached here to the gas formation through chemical decomposition in stomach or small intestine. By laxation and enemas the material for gas formation through processes of fermentation and decomposition in the colon has been much reduced. Gas formation here does not explain the presence of gas in stomach and small intestine. It also generally takes place too slowly to allow it to be assumed as the cause of the production of meteorism in these cases, even on the presumption of a retarded absorption. It is clear, therefore, that the main bulk of the gas must originate from elsewhere.

Investigations into the absorption and diffusion of intestinal gases have shown that the gas exchange between intestine and blood follows the laws of diffusion (R. SCHOEN, 2, MC IVER, REDFIELD and BENEDICT, 3, and others). There are no indications for assuming any gas secretion from the intestinal wall. The gaseous exchange thus takes place in a direction of creating equilibrium between partial tensions of individual gases in blood and intestine. Analogous conditions obtain with regard to the gaseous exchange through the serous membranes. According to R. SCHOEN (2) no diffusion takes place to a small intestine empty of gas, not even in circulatory disturbances experimentally produced. The same author has found gas formation in the colon under similar conditions. More marked gas formation (in the small intestine, too) after circulatory disturbances in intestinal coils, initially empty of gas, has been described by KADER (4). If the gas in these experiments had arisen through diffusion one ought also to be able to demonstrate gas diffusion to the serous cavities in circulatory disturbances. No such diffusion, however, has been

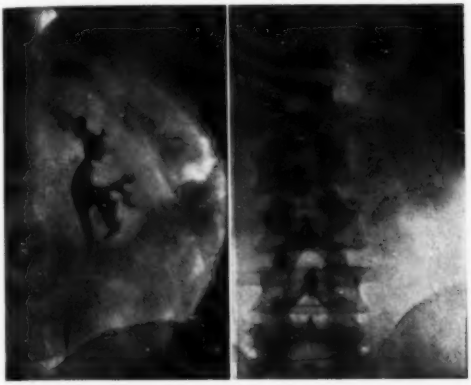
observed. It would seem, therefore, that the gas in the experiments referred to had largely arisen through chemical decomposition of intestinal contents or transudates.

In the presence of gas in the intestine gases with a higher partial tension in the intestine are absorbed by the blood which in its turn gives off to the intestine such gases that have a greater partial tension in the blood than in the intestine. Gases that can conceivably be given off from the blood to the intestine are O_2, N_2 and CO_2.

O_2 has never been found in intestinal gases except in exceedingly slight quantities (RUGE, 5, and others). It does not seem likely, therefore, that one could reckon with any voluminous increase through diffusion of O_2. At a low partial tension of N_2 in the intestine this gas may be given off from the blood (MC IVER, REDFIELD, BENEDICT, 3, and others). As, however, the other gases present in the intestine are absorbed quicker than N_2 is given off, diffusion of N_2, neither, can bring with it any increase in the volume of the intestinal gas. — Under ordinary conditions the partial tension of CO_2 is higher in the intestine than in the blood, (see RUGE's, 5, analyses of intestinal gases) wherefore no CO_2-diffusion generally takes place from the blood to the intestine. In severe circulatory disturbances the partial tension of CO_2 in the blood is increased whereby such a diffusion becomes possible. — In experimental circulatory disturbances MC IVER, REDFIELD and BENEDICT (3) have shown a voluminous increase of about 25 % in 2 hours by the formation of CO_2 in intestinal coils already filled with N_2 or H_2. On filling with CO_2 one obtained instead about 50 % decrease in the volume in the same space of time. — Not even in severe circulatory disturbances experimentally produced has one been able to obtain a gas diffusion from the blood which in a few hours has resulted in a meteorism of a magnitude as that present in the cases of pyelography. — Moreover would it seem impossible for about half-a-litre of gas to be formed in the stomach in 10 minutes through diffusion from the blood as happened in the above cases, because the quantity of blood that in the time mentioned can conceivably pass the mucous membrane of the stomach can scarcely contain, still less give up, such a great quantity of gas. It will be clear, therefore, that gas diffusion from the blood, neither, can explain the meteorism in the cases under discussion.

The main bulk of the gas must therefore consist of air that has passed down via the oesophagus. This accords well with the nearly always regularly present and oftentimes very considerable gaseous distension of the stomach.

In the study of cases of aerophagia it has been shown that large quantities of air can pass down into the stomach in a brief space of time. Often it is not a question here of ordinary swallowing but of »inspiration»



a *b*

Fig. 1. *a* taken 10 minutes after *b*. Note the air in the oesophagus in *b*.

a

b

Fig. 2. *a* and then *b* taken in upright position at an interval of 5 minutes, during which the patient was lying on his left side; no belching in the meantime. Note the air in the small intestine in *b*.

Fig. 3. Before 'inspiration' with closed glottis.

Fig. 4. 3 minutes after fig. 3.

Fig. 5. 8 minutes after fig. 3.

Fig. 6. 18 minutes after fig. 3.

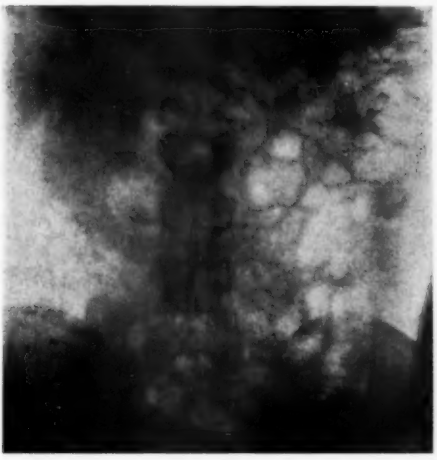


Fig. 7. 30 minutes after fig. 3.
(The main bulk of gas now in the colon.)

Fig. 8. Before inflation of air into the stomach.

Fig. 9. 6 minutes after inflation of air. Note the air in the caecum.

Fig. 10. 11 minutes after inflation of air.

Fig. 11. 20 minutes after inflation of air. Note the air in the transverse colon.

of air through the oesophagus with closed glottis. This is illustrated by an experiment with air »inspiration» that the author did on himself (fig. 3—7) at which in 3 minutes a quantity of air estimated to about $^3/_4$ litre passed down to the stomach. — To be able to explain the rapidly arising colonic meteorism in cases of pyelography as being due to swallowed air it must be presumed not only that the air in the stomach to a large extent passes out to the small intestine but also that the air passes through the small intestine in a very short space of time and very much quicker than the fluid contents which of course take 2—4 hours for their passage.

The gas contained in the stomach settles in relation to the horizontal plane in the highest part of the organ, thus in erect and right side-lying position in the fornix, in supine and left side-lying position in the transverse part of the stomach. A large portion of the air swallowed with the food or otherwise is got rid of by belching, if the patient is in the erect or right side-lying position. In these positions fluid collected in the pyloric part of the stomach serves as a lock to the passage of gas through the pylorus. The belching of air is rendered more difficult in supine or left side-lying positions, especially after meals when the cardia is covered by fluid contents. In these positions the gas passes instead through the pylorus, demonstrated by KANTOR (6) and others, and which will be illustrated by the experiments to be described below. (Fig. 2.) This may explain why bed-ridden patients generally have more intestinal flatulence than those who are up and about. In the case of an otherwise empty stomach the gas passes the pylorus also in erect and right side-lying position but slower than in other positions.

As far as I am aware the passage of gas through the small intestine has not been more closely studied. In experiments on himself with regard to gas absorption in the stomach YLPPÖ (7) found that a troublesome flatulence arose as a rule 2—3 hours after the stomach had been inflated with air. Beyond that I have been unable to find, with regard to the passage of gas through the small intestine any data as to the time occupied for such passage. I have therefore made some investigations into this question.

Most of these experiments have been carried out with the patient in left side-lying position for facilitating the passage of gas through the pylorus. To avoid confusing the gas in the small intestine with that of the colon and with the view to rendering it easier to determine the time of entry of the gas into the caecum the colon was first filled with an opaque enema. The patient was then laid on his left side for a few minutes to enable one to see how much of the gas in the colon collected in the caecum. — Gas was then introduced into the stomach. In the first experiments CO_2 was used, this being formed in the stomach after ingestion of tartaric acid and bicarbonate. — As this gas is rapidly absorbed (most

of it had disappeared from the intestine after 45 minutes) I used instead air in subsequent experiments, the air being pumped down to the stomach by a stomach tube. (Fig. 8—11.)

In all the cases examined the passage of air through the pylorus could be observed almost immediately after it had been pumped down into the stomach. At the same time those sounds commenced, so characteristic of the passage of gases through the small intestine (CANNON, 8), afterwards persisting as long as air remained in the small intestine. At first was noticed a nearly continuous distension of the upper jejunal coils, later the same coils were seen to be the seat of a gradually more obvious segmentation, the gas being divided up into smaller gas pillars and the distension becoming less and less marked. The greater amount of gas contained in the stomach, the greater is the quantity of gas that seems to pass the pylorus per time unit. The segmentation of the gas always seemed to be more marked in the more distal parts of the small intestine. The speed of the passage could be best observed in the left flank in places where several coils of small intestine were not superimposed over one another. On screening examination with the patient in erect position it could be seen how the passage upwards in relation to the horizontal plane was very much quicker than in other directions, explained by the low specific weight of the gas in relation to the surroundings.

That the gas had passed down to the caecum could be ascertained by the rapidly increasing gas distension here after a space of time varying between 6 and 15 minutes in the different cases. See fig. 9. — The colon then rapidly filled up with gas. After about 30 minutes there was generally only a slight quantity of gas left in the stomach and after 45 minutes the small intestine was very nearly empty. In the majority of cases flatulence came on forcibly after about 30 minutes. Experiments carried out with the patient in supine position shows the same time occupied for passage through the small intestine but the stomach empties more slowly then than in left side-lying position.

The passage of gas through the small intestine thus seems to take about 10 minutes. Under favourable postural positions the whole digestive tract can be passed in 30 minutes.

The above-mentioned conditions for the possibility of colonic meteorism in cases of pyelography being due to swallowed air that has passed through the stomach and the small intestine are thus fulfilled.

With regard to the cause of aerophagia in these cases it may be mentioned that similar meteorism is often also observed in cases of intravenous pyelography and in attacks of renal colic. BICKEL (9) found in his studies of coma — in which he injected, intravenously, strong solutions of glucose and obtained well marked polyuria — that considerable meteorism rapidly supervened in the experimental animals. By ligating

the oesophagus prior to the injection no meteorism occurred. It is clear, therefore, that it must be due to air passed down through the oesophagus. By reason of this it is natural to assume that the swallowing of air or rather the »inspiration» of air through the oesophagus in pyelography is due to some reflex impulse emanating from the urinary tract.

The fact that swallowed air is a source of the intestinal gases may largely explain the ineffectivity, so often referred to, of our measures in getting rid of intestinal gases for roentgen examinations. That under normal conditions air is swallowed during as well as between meals has been known for long. As to the quantities swallowed, however, I have been unable to find any data in the literature. Nor is it possible exactly to calculate it from the amount of N_2 in the flatus as some of it may be due to N_2-diffusion. The swallowing of air is markedly increased in catarrhal and inflammatory conditions of the pharynx and oesophagus and also in various kinds of digestive disturbances (symptomatic aerophagia, FABER 10, WINKELSTEIN 11). — It was mentioned above that most of the swallowed air is belched up in the erect position of the body, but in supine and, above all, left side-lying position it passes on into the intestine.

For the methods for getting rid of intestinal gas to be effective it is not enough to remove the contents from the colon. In my opinion one must also prevent the passage of air through the oesophagus or, if this cannot be done, trying to facilitate the belching of swallowed air and to prevent its passage through the pylorus. As we have no practical method at our disposal for preventing the air from passing down through the oesophagus, we must confine ourselves to the latter procedures.

The belching of air contained in the stomach can be suitably facilitated by letting the patient on the day of examination occupy an upright (maybe sitting) position before the examination. If the patient has to be in the recumbent position he must be on his right side. If possible cystoscopy should be carried out with the head end of the table raised. Even between the exposures on the roentgen couch supine position should be avoided (as also left side-lying position).

The passage of air through the pylorus is counteracted by giving the patient small quantities of fluid (about 150 c.c. of non-effervescent water every hour). In the upright or right side-lying position a fluid lock is thereby created to the passage of air into the small intestine. — Pyelography should be carried out as soon as possible after the cystoscopy, enemas or intestinal lavage as shortly before the roentgen examination as is convenient. We have as yet only been trying the above-mentioned measures for a short time. In cases where they have been carried out with minute care they seem to have yielded good results. No disadvantage has been noticed from letting the patient take fluids by the mouth, and

it must be deemed of benefit to the patient not to starve completely. — The value of the method is further evidenced by everybody's experience that patients who are up and about generally have much less meteorism than bed-ridden patients. The difficulty lies in the necessity of exact execution of the measures. If the patient lies on his back or on his left side only for a short while, the air passes on into the intestine and the result is jeopardized.

That the swallowed air in so far that it passes through the pylorus has a great bearing upon the volume of intestinal gas is explained by the fact that up to four-fifths of it is made up of N_2, none of which, practically, is absorbed in the digestive canal. There is reason for assuming that even in other cases of meteorism than those mentioned here it plays a greater part than is generally believed. Investigations by Mc Iver, Benedict and Cline (12) concerning among other things post-operative meteorism point in this direction.

SUMMARY

In pyelography well-marked meteorism is of strikingly common occurrence. It is characterised by its rapid onset and by a more or less marked gaseous distension also of the stomach. On the strength of this the author concludes — after a brief review of the origin of intestinal gases — that the gas in the present case is made up of swallowed air and that it cannot have arisen through processes of chemical decomposition in the digestive tract or by diffusion from the blood.

Earlier investigations and the author's own experiments go to show that in supine position and, above all, in left side-lying position the gas passes rapidly out into the small intestine. This explains why intestinal flatulence is generally more common in patients who are in bed than those who are up and about. The author has investigated the speed of passage of the gas through the small intestine (by inflating the stomach and by filling up the colon with opaque substance). The experiments show that the gas passes through the small intestine in about 10 minutes and that the whole of the digestive tract under favourable postural conditions can be passed in half-an-hour. In an experiment on himself with air-»inspiration» through the oesophagus with closed glottis the author found that about $^3/_4$ of a litre of air could be introduced into the stomach in 3 minutes. There is nothing, therefore, that is against the meteorism being explained by swallowed air.

Similar meteorism occurs also in intravenous pyelography and in attacks of renal colic. Concurrently with polyuria as a result of intravenous injections of glucose (in dogs) a rapidly occurring meteorism has been demonstrated due to swallowed air (A. Bickel). It would seem, therefore that swallowing of air can be elicited by impulses from the urinary tracts.

The observation of swallowed air as a source of intestinal gases can well explain the ineffectivity of the measures we adopt to free the intestine from gas as a preparation for roentgen examinations. Belching of swallowed air is facilitated in erect or right side-lying position and the passage of gas through the pylorus can be prevented by taking water by the mouth (about 150 c. c. per hour), provided that these positions of the body are strictly adhered to.

There is reason to assume that the swallowed air also in other cases than those mentioned here plays a greater part in the occurrence of meteorism than is generally believed.

ZUSAMMENFASSUNG

Bei Pyelographien ist auffallend häufig ein bedeutender Meteorismus zu beobachten; er kennzeichnet sich durch sein rasches Auftreten und dadurch, dass sich die mehr oder weniger hochgradige Gasauftreibung auch auf den Magen erstreckt. Hierauf gestützt, kommt Verf. nach einem kurzen Überblick über die Quellen der Darmgase zu dem Schluss, dass das Gas im vorliegenden Falle aus hinuntergeschluckter Luft besteht und nicht durch chemische Zersetzungsprozesse im Verdauungskanal oder durch Diffusion aus dem Blute entstanden sein kann.

Ältere Untersuchungen und die eigenen Versuche des Verfassers zeigen, dass das im Magen vorhandene Gas bei Rückenlage und vor allem bei l. Seitenlage rasch in den Dünndarm hinausgelangt. Hierdurch lässt sich erklären, dass liegende Patienten meistens mehr Darmgase haben als die ausser Bett befindlichen. Verf. hat (durch Einpumpen von Luft in den Magen und Kontrastfüllung des Kolons) die Geschwindigkeit der Dünndarmpassage des Gases untersucht. Die Versuche zeigen, dass sich der Durchtritt des Gases durch den Dünndarm ungefähr binnen 10 Minuten vollzieht, und dass unter günstigen Lagebedingungen der ganze Verdauungskanal in einer halben Stunde passiert werden kann. In einem Selbstversuch mit Luft-»inspiration» durch den Ösophagus bei geschlossener Glottis konnten dem Magen in 3 Minuten ungefähr $^3/_4$ Liter Luft zugeführt werden. Es besteht also kein Hindernis für die Erklärung der Entstehung des Meteorismus durch hinuntergeschluckte Luft.

Ein ähnlicher Meteorismus kommt auch bei intravenösen Pyelographien und bei Nierensteinanfällen vor. Gleichzeitig mit einer durch intravenöse Glykoseinjektionen (an Hunden) entstandenen Polyurie wurde ein rasch auftretender Meteorismus nachgewiesen, der auf hinuntergeschluckter Luft beruht (A. Bickel). Das Schlucken von Luft scheint daher durch Impulse von den Harnwegen ausgelöst werden zu können.

Die Beobachtung der hinuntergeschluckten Luft als Quelle der Darmgase kann die Wirkungslosigkeit unserer Massnahmen zur Befreiung des Darmes von Gas für Röntgenuntersuchungen erklären. Aufstossen von hinuntergeschluckter Luft ist in aufrechter Stellung oder r. Seitenlage erleichtert, und der Durchtritt von Gas durch den Pylorus wird durch Zufuhr von Wasser (ca. 150 cm³ per Stunde) verhindert, wenn diese Körperlagen konsequent eingehalten werden.

Man hat Grund zur Vermutung, dass die hinuntergeschluckte Luft auch in anderen als den hier erwähnten Fällen eine grössere Rolle für die Entstehung von Meteorismus spielt, als man im allgemeinen angenommen hat.

RÉSUMÉ

Dans les pyélographies, on observe d'une façon particulièrement fréquente un météorisme marqué. Il est caractérisé par son apparition rapide et par une dilatation gazeuse plus ou moins marquée, même de l'estomac. S'appuyant sur ce fait et après une courte revue sur l'origine des gaz intestinaux, l'auteur conclut

que, dans le présent cas, le gaz est constitué par de l'air dégluti et non par des gaz provenant de décompositions chimiques dans le tube digestif ou de diffusion du sang.

Des recherches antérieures et celles de l'auteur montrent que, dans le décubitus dorsal et surtout dans le décubitus latéral gauche, les gaz de l'estomac passent rapidement dans l'intestin grêle. Ce qui explique que les malades alités ont souvent plus de gaz intestinaux que les malades debout. L'auteur a étudié la rapidité du passage des gaz dans l'intestin grêle, en pompant de l'air dans l'estomac et remplissant le colon d'un milieu de contraste. Ces expériences montrent que le passage des gaz à travers l'intestin grêle a lieu dans un délai d'environ 10 minutes, et que, dans certaines positions favorables, le tube intestinal tout entier est traversé en une demi-heure. Dans une expérience faite sur lui-même par »inspiration» d'air par l'œsophage, la glotte étant fermée, l'auteur a pu introduire environ $^3/_4$ de litre d'air dans l'estomac en 3 minutes. Rien ne s'oppose donc à ce qu'on explique le météorisme par déglutition d'air.

On observe un météorisme analogue dans les pyélographies intraveineuses et dans les accès de coliques néphrétiques. Simultanément avec une polyurie provoqué chez le chien par des injections intraveineuses de glycosine, on a observé un météorisme rapide dû à la déglutition d'air (A. Bickel). L'aérophagie semble donc pouvoir être déclanchée par un réflexe venant des voies urinaires.

L'observation faite de l'air dégluti comme cause des gaz intestinaux peut expliquer l'inefficacité des mesures par lesquelles nous cherchons à débarrasser l'intestin de gaz en vue de l'examen radiographique. Le renvoi d'air dégluti est facilité dans la position debout ou dans le décubitus latéral droit et le passage des gaz à travers le pylore est empêché par l'administration d'eau (env. 150 cm³ par heure) dans les positions indiquées ci-dessus.

On a lieu de supposer que l'aérophagie joue, dans d'autres cas, un rôle plus important qu'on ne l'avait pensé dans la production du météorisme.

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FROM THE ROENTGEN INSTITUTE OF THE ROYAL SERAFIMER HOSPITAL, STOCKHOLM
(CHIEF: PROF. GÖSTA FORSSELL)

A CASE OF ANEURYSM OF THE HEART[1]

by

Gunnar Wiberg

The fullest description, so far, of the clinical conditions in connexion with aneurysm of the heart is the one given in 1914 by STERNBERG (16). He, partly from his own observations, partly from what had already been written by others on the subject, came to the conclusion that there could be distinguished in the course of the disorder certain definite, more or less characteristic stages, viz those of 1) stenocardiac attacks, 2) pericarditis and episternocardiac malacia, 3) slight or apparent healing, 4) serious injury to the heart muscle. In his publication he instances a case diagnosed by him as aneurysm of the heart from the clinical symptoms alone, which diagnosis was eventually confirmed by the autopsy.

Nevertheless, as proved by post mortem findings, most cases of this affection still passed undiagnosed, owing in part, no doubt, to lack of knowledge of how to interpret the clinical symptoms, though probably also in many cases because such symptoms were altogether absent; the course of an aneurysm of the heart being, in fact, not infrequently unmarked by any distinctive clinical manifestations. It was therefore a great step forward when it was found that the diagnosis in a number of cases, in which the clinical symptoms of the aneurysm were either totally absent or else not fully characteristic, could be established roentgenologically, and that the roentgen examination also in many instances would serve to confirm a clinical diagnosis already made. On this subject a number of communications have been made during the last ten years or so, mostly by French and German authors. Of a total 9 cases thus reported, in which the diagnosis was made by roentgen examination during life, it is true that only the fewest (6, 8) were subsequently verified by autopsy; still, also in most of the others the investigation was so thorough as to place the correctness of the diagnosis, even without such verification, beyond all reasonable doubt.

[1] Submitted for publication Nov. 11th, 1931.

From the dissimilarity of their roentgenological characters, aneurysms of the heart may well be divided into those localised to either the apex or the diaphragmatic surface and those formed in other portions of the organ. The former are namely, as study of the published cases plainly shows, least favorably situated for observation, as proved by the fact that they in every case escaped the notice of the investigator, though some of them were of quite considerable size. Such, for instance, was the case with two separate apical aneurysms described by LUTEMBACHER (12), one of them the size of a hen's egg and the other almost as large as the heart itself. In neither case was the tumor visible to the roentgen observation, and LUTEMBACHER's explanation of this seems very plausible. He points out that an aneurysm in the apex will have a tendency to develop chiefly downwards, and will thus come to lie within the field of what the French call: *l'ombre hépato-diaghragmatique*. In one of his cases the aneurysm had even produced a depression in the surface of the liver, and lay hidden therein. Though there may thus very often be no direct symptom of an aneurysm in the apex of the heart, LUTEMBACHER nevertheless considers certain signs as indirectly pointing to its presence. In one case he thus during the screening of the patient observed a fixation of the apex, which was ascribed to pericardial adhesions such as often occur within the area of an aneurysm. That, at the same time, all clinical symptoms of such adhesion — in the form of systolic inspiration, etc. — were absent, while pressure with a finger on the thoracic wall over the supposed site of the aneurysm produced a pain, is by LUTEMBACHER taken as to a certain extent indicating that an aneurysm really existed. Also BRUNET (3) considers the fixation of the apex of the heart, in connexion with a sensation of pain when pressure is exerted above the latter, as supporting the diagnosis of aneurysm. Inasmuch, however, as those pericardial adhesions may be lacking, the symptoms are evidently not constant.

The difficulty of diagnosing these aneurysms localised to the apex or the diaphragmatic surface of the heart is best illustrated by a case reported by CHRISTIAN and FRIK (4), who had diagnosed what they believed to be an aneurysm in the upper part of the left ventricle. Instead, the post mortem showed an aneurysm in the apex, while in the place where they had suspected one there was found an hypertrophy of the heart muscles, forming an imposing pulsating bulge in the outline of the heart. In the case published by JAKSCH-WARTENHORST (6) in 1925, the screening revealed near the apex of the heart some shadows of calcareous density, which appeared rather to follow the movements of the organ. It was suggested that it might be a case of calcareous infiltration inside an aneurysm, though, at the same time, the possibility of pericardial calcifications could not be altogether excluded; the post mortem showed that the calcareous deposits were localised to a thrombosed aneurysm.

To diagnose an aneurysm in the apex or diaphragmatic surface of the heart by roentgen alone would thus appear to be a very difficult matter, and in fact only possible when there are calcareous infiltrations inside the tumor. Even so, the calcification would have to be considerable, because the movements of the heart will make a merely slight and thin calcareous deposit appear only as a vague smudge in the film. The diagnosis of aneurysms in the portions of the heart above the apex would seem to be considerably easier, even rather small ones being observed without difficulty. Thus, one described by HEITZ and CORONE (5) was only as large as a hazel nut, but could nevertheless be observed in a variety of projections under the screening.

Aneurysms of the heart, like those of the aorta, present certain peculiar characteristics. Thus, it is stated that the appearance of the tumor shadow on the screen is that of a more or less sharply marked, rounded swelling, which shows systolic expansion and synchronal pulsatory movement; and by turning the patient it can be ascertained that in all directions there is a broad-based junction between the shadow of the aneurysm and that of the heart. As regards the other symptoms already alluded to, the statements of the various communications are often brief, but in all the cases both the co-pulsation and the broad-based junction of the shadows were noted. Independent pulsation could be observed in most of the cases. Another symptom peculiar to aneurysms of the heart is said to be their following the displacements of the latter, both respiratory and when the patient bends to one side or the other. In cases where there are pericardial adhesions with consequent fixation of the tumor it is probably doubtful, however, whether this symptom will be present. The density of the aneurysmal shadow appears to vary considerably. In the case described by BIANCHI (2) it was no denser than that the coarser features of the lung design could be discerned through it, while in HEITZ and CORONE's (5) case its density equalled that of the heart's. Also the homogeneity of the shadow varies, according to the statements. Thus, in the case described by SEZARY and ALIBERT (15) there was a greater density of the peripheral zone, which the authors would explain as due to adhesions surrounding the aneurysm. It is probably doubtful, however, whether adhesions alone would suffice to produce a denser shadow in the film, especially when it is remembered that, as already noticed, even thin calcareous shadows are apt to be overlooked. There was no post mortem in this case, but the probability is that those denser shadows were in reality due to a relatively advanced calcification.

The etiology of aneurysms of the heart is too vast a subject to be gone into here. It may be indicated, however, that arteriosclerosis and, in the second place, lues — both of which give rise to thrombotic processes in

the coronary vessels, with subsequent myomalacia — are the most frequent causes. In one case, LENK (11) with the aid of a secondary diaphragm succeeded in demonstrating the presence of two parallel lines of calcium shadow within the shadow of the heart, and these he interpreted as calcareous infiltrations in a coronary artery, pointing to advanced arteriosclerosis of the latter. A special place, as regards etiology, may be claimed for the case reported by BIANCHI (2), inasmuch as the aneurysm there was probably due to traumatism, viz a shrapnel wound in the chest.

In proceeding now to the description of a case of aneurysm of the heart observed in the Serafimer Hospital in Stockholm, I first, for the sake of greater completeness, give a brief summary of the clinical symptoms (a more detailed account of which may be found in an article by B. STRANDELL, in the Acta Medica Scandinavica, 1930).

The patient was a musician, 42 years old. At the age of 26 he contracted syphilis, for which he was treated during four years. After that his health continued good until the summer of 1928, when he was suddenly and without any foregoing symptom seized with an attack, lasting fifteen minutes, of palpitation of the heart, intense anxiety, and pains radiating out into the arms; the latter, according to his own description, feeling like strokes coming simultaneously with every beat of the heart. For some time he continued to have such attacks daily, but eventually his condition improved under treatment with digitalis, and he remained fairly well until February 1929, when he suddenly, during a walk, became paralytic in the left arm and leg and at the same time lost the power of speech (note: he was left-handed). In a couple of hours the attack was over, and there remained only a shortness of breath at the least effort, and a pulse frequency of 160 to the minute. He was then admitted to the hospital at Söderhamn, where a fluoroscopic examination on May 10th showed him to be suffering from »enlarged heart of the aorta type». After a sudden change in the pulse frequency he felt well again; but already on May 13th he sought the Policlinic of the Serafimer Hospital, compaining of fatigue, strong palpitation of the heart and shortness of breath. As these symptoms continued to increase, he was on June 3rd admitted into Medical Clinic I. At the time of his entrance there he showed no signs of either cyanosis or dyspnea. The dimensions of the heart were 3 + 14 centimeters. Over the whole extent of the organ was heard a medium strong systolic souffle, and over the aorta further a slight additional sound immediately before the accentuated A II. The rhythm was not entirely regular; with long intervals there would come some irregular beats. The frequency was 60 to the minute. No peripheral arterial sounds. No capillary pulse. Blood pressure, 125 and 80. Wassermann positive in the blood.

For a while afterwards he was treated policlinically with potassium iodide and neotropol; but on July lst he got an attack of angina pectoris, which lasted for several hours, and was once more taken into the hospital. From the 8th to the 19th of July he lay in a marked anginal condition with continued attacks of constricting pains in the chest, tachycardia and irregular pulse. In the beginning, cardiac medication of various kind had no effect, but little by little his condition improved, and from July 23rd he was fairly well. Only now and then he would

have some slight pains in the left arm, but these eventually disappeared under treatment with nitroglycerin. Apart from this he complained of trouble in swallowing, in that he felt a stabbing pain in the lower part of his chest about three or four seconds after passing down a mouthful. During this period of hospitalisation he was roentgen-examined at the Roentgen Institute of the Serafimer Hospital on August 1st and Sept. 18th.

On Sept. 21st he was discharged, and was then again treated policlinically until Oct. 16th, when he had an acute attack of suffocation, with pains in both arms. This was overcome by the immediate administration of digitalis and nitroglycerin, but the improvement proved only temporary, and on Oct. 18th he entered the Medical Clinic for the third time. At that time he was extremely dyspneic, highly cyanosed, and in a condition of delirium cordis. He was roentgen-examined on Nov. 2nd. Little by little, the symptoms of lacking compensation became more and more accentuated, and on Dec. 24th he died.

At the first roentgen examination in the Serafimer Hospital, on Aug. 1st, the screening showed a heart with rather weak contractions. What immediately arrested attention was a well defined outward bulge in the left contour of the organ. This certainly followed the heart in its contractions and respiratory displacements, but one nevertheless had the impression of a retardation or slackening of the heart movements over this area. Independent pulsations could not be observed. By turning the patient about 20 degrees to the left one got a somewhat more definitely marked angle between the upper margin of the bulge and the contour of the left ventricle of the heart, and at the same time the outbulging part became somewhat broader, and its lateral contour came nearer to the thoracic wall. On further turning, the tumor again showed less broad, and with the lateral projection at a little over 45 degrees it was completely hidden by the normal anterior contour of the heart. When starting from the frontal position and turning the patient to the right, its bulge gradually became smaller, and at a little less than 45 degrees it disappeared in the posterior contour of the heart. It could not, under these turnings, be projected clear of the shadow of the heart, and in every projection it showed the same broad junction with the latter. The left diaphragm showed normal mobility, and the sinus filled well.

The roentgenograms (Fig. I) show in the left outline of the heart the tumor observed during the screening. It begins about 3 centimeters below a shallow incurvation, which we must suppose indicates the distinction between the pulmonary arch and the left ventricle. In the 20 degrees' sideway projection indicated above, where it appears in its fullest development, it measures about 2.5 centimeters in thickness. Its inferior boundary, in contrast to the superior one, cannot be exactly determined, because it is hidden by the shadow of the liver. In the lateral view (Fig. II) there is seen within the heart a rounded patch of greater density, almost corresponding in size to — and in all probability repre-

senting — the bulge in the frontal picture. This bulge, which showed the same rounded shape in all projections, was about the size of an orange. Its density, which was uniform throughout, was somewhat less than that of the rest of the heart shadow's. For the rest, the examination of the

Fig. I. Frontal view of the Heart, Aug. 1st, 1929.

Fig. II. Lateral View of the Heart, Aug. 1st. 1929.

heart showed enlargement of the right ventricle, and posteriorly an outward curving which was interpreted as due to dilatation of the left atrium.

From the roentgenograms as well as the fluoroscopic observations, the location of the tumor was taken to be in the lower part of the left ventricle. Whether the apex of the heart was engaged it was in this case impossible to determine, owing to the impossibility of tracing the inferior margin. Fig. III, which represents a graphic transverse section through the heart and thorax, shows the antero-posterior extent of the bulge as reconstructed on the basis of the fluoroscopic findings. With the object turned 20 degrees to the left its breadth is somewhat larger than under frontal projection. When the turning to the left is continued, the shadow disappears at a little more than 45 degrees (corresponding to the line a—a_1). With the subject turning to the right, it disappears at a little *less* than 45 degrees (corresponding to the line b—b_1). The straight lateral projection appears to accord with Fig. II.

As regards diagnosis, the possibilities naturally lay between aneurysm of the heart, neoplastic growth and gumma — the latter on account of the patient's lues. A neoplasm was highly improbable, however. As a matter of fact, neoplasms of the heart are very rare, and when found it

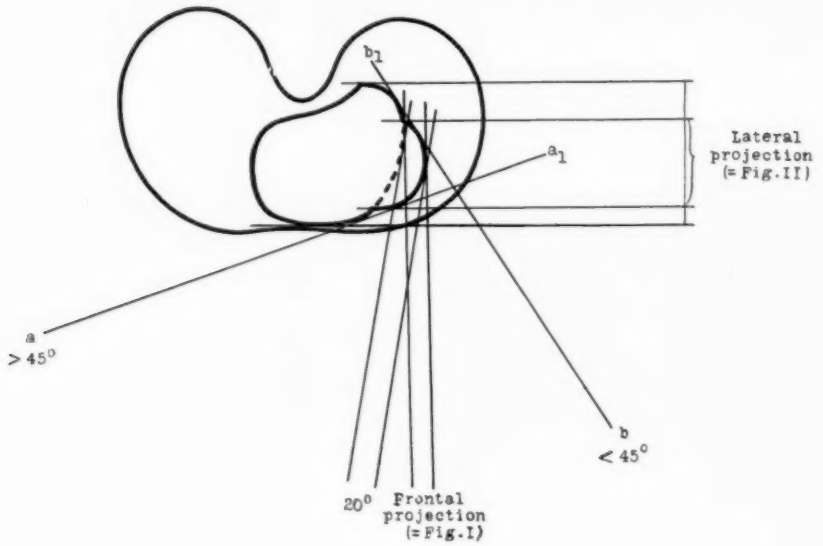

Fig. III.

is usually, as the scant literature on them shows, in the right half of the organ. Of neoplastic growths in the left half of the heart only a very few descriptions exist, and in every one of those the growth arose from the atrium. Of gummata in the wall of the heart being recognised roentgenologically the literature does not, to my knowledge, record a single instance; and even if it were possible to imagine a gumma of that size localised to the wall of the heart, it would almost certainly be impossible roentgenologically to distinguish it from an aneurysm.

In view of all this the diagnosis: aneurysm of the heart thus remains the most likely one, and that in spite of the fact that so important a symptom as independent pulsation was lacking; its absence being ascribed to thrombosis of the aneurysm.

A second roentgen examination, on Sept. 18th, showed conditions unchanged since the former occasion.

A month later, on Oct. 18th, the patient was brought in, with pronounced symptoms of lacking compensation. Roentgen examination Nov. 2nd (Fig. IV) now showed a marked change, in that the heart had become considerably broader. Owing to this, in connexion with the stasis that had set in in the lungs, most markedly so towards their base, and also to a bilateral hydrothorax, the aneurysm could then no longer be observed.

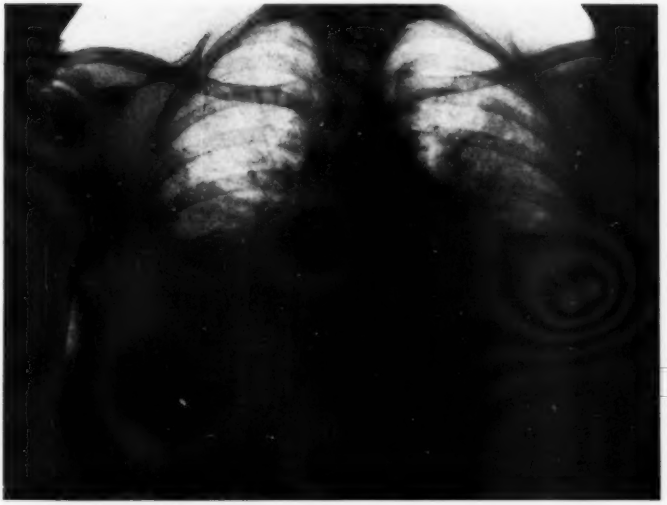

Fig. IV. Frontal View of the Heart, Nov. 2. 1929.

The autopsy showed the two pericardial layers to be soldered together by solid connective tissue. In the left wall of the left ventricle was an outward bulge, as large as a good-sized orange (Fig. V), beginning a little above the apex, and its upper margin about 4 centimeters below and to the left of the aortic orifice. Especially above this bulge the tissue connexions between the pericardium and the epicardium were strongly developed and of a rind-like consistency. The tumor was found to communicate with the cavity of the left ventricle through a circular aperture about 4 centimeters in diameter, opening into the left wall of the chamber about midways between the apex and the mitral orifice. The greater part of the tumor itself was filled with thrombotic masses. The thickness of its wall varied from 1 to 2 centimeters; its outer layer was formed of the parietal layer of the pericardium. The entire formation appeared to lie outside the circumference of the left ventricle. Section through the wall showed no muscular tissue; on the other hand, calcareous incrustations of various extent could be felt both in the wall itself and along the line of its junction with the ventricle.

Above the tumor here described there was found, in the posterior surface of the heart, another similar, quite as large one (b, Fig. VI). It, too, communicated with the left ventricle, through an aperture 3.5 centimeters in diameter, immediately below and back of the posterior cusp of the mitral valve. The inferior margin of this aperture lay about 2 centimeters higher than the upper margin of the other one. The wall

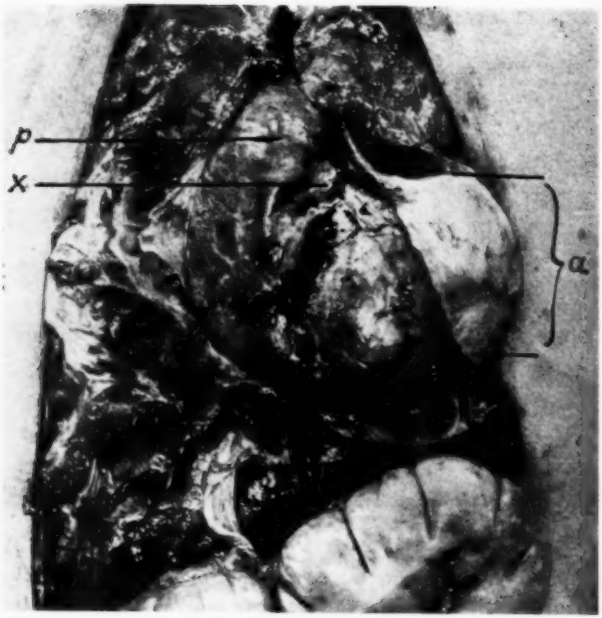

Fig. V. *The heart in situ.* *a*, The outward bulge in the left circumference of the left ventricle, with its coat of rind-like pericardial adhesions; *p*, Pulmonary artery; *x*, Aortic orifice.

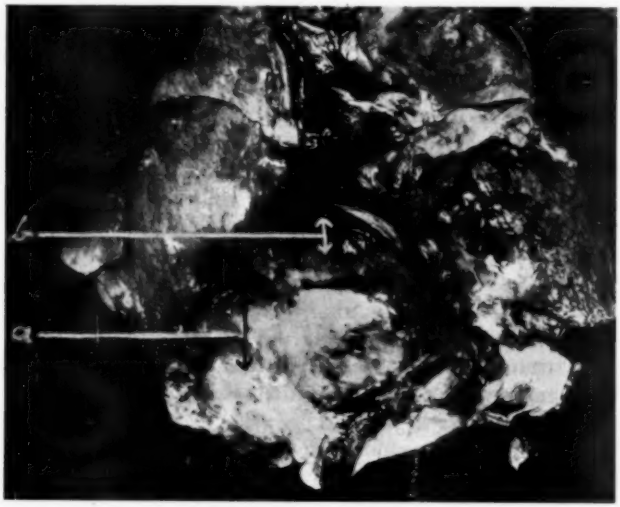

Fig. VI. *Posterior view of the heart and lung.* *a*, The aneurysm — here cut open — which at the roentgen examination was observed in the left circumference of the left ventricle; *b*, the aneurysm] in the posterior wall of the heart, which was not observed in course of the roentgen examination, but subsequently disclosed by the autopsy.

of this tumor presented about the same appearance as that of the other, and its inside was covered with thrombotic masses, which almost completely filled the lumen of the formation.

The two tumors thus found were interpreted as aneurysms. A microscopical examination of the coronary artery made at the same time gave as result that the case was one of arteriosclerotic processes — not of luetic ones, as might have been expected.

The location of the aneurysm nearest the apex thus proved to be precisely as concluded from the roentgen examinations. Even the supposition that the case was one of a thrombosed aneurysm proved correct. In this case, however, the calcareous infiltrations in the tumor wall furnished no support for the diagnosis; probably owing to the circumstance already dwelt on, that relatively slight calcareous deposits will not appear with any degree of sharpness in the roentgen picture, on account of the movements of the heart; and in the roent-geno-gram of the removed, formalin-hardened heart the palpated laminae of calcareous matter appear as rather thin (see Fig. VII). As to the retardation of the heart movements observed during the screening no definite opinion has been ventured; but the explanation undoubtedly lies in the pericardial adhesions.

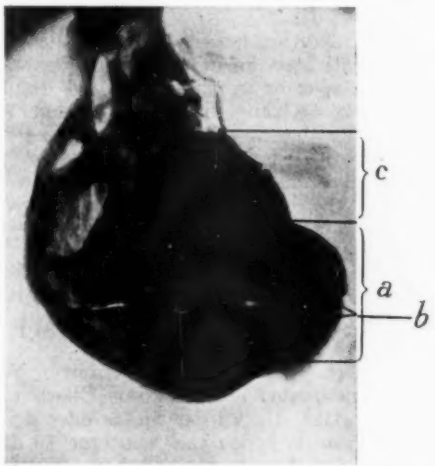

Fig. VII. *Roentgenogram of the removed, formalin-hardened heart* (some small sections have been cut out for pathoanatomical diagnosis). *a*, the aneurysm nearest the apex; *b*, the thin, lamellar condensations due to calcareous deposits in the wall of the aneurysm; *c*, the upper aneurysm.

In certain ways the aneurysm that was not diagnosed presents a greater interest than the observed one, inasmuch as it shows that even aneurysms situated high up can present considerable difficulties in the matter of diagnosis. It is true that in this case no one counted with the possibility of two aneurysms, and that the whole attention therefore was concentrated on determining the location of the one first observed; but not even when going over the roentgenograms afterwards, with full knowledge of the location of the second one, is it possible with any degree of certainty to trace out the latter. From comparison between the roentgenograms taken during life and those of the removed and formalin-hardened heart it appears as if, in the frontal

view, it might be represented by the contour seen above the lower tumor; but, on the other hand, that outline might as well be the shadow of the left ventricle. In the picture taken with the subject turned 45 degrees to the left, the second aneurysm probably contributes to what impresses one as a very much enlarged left atrium. If the mind of the investigator had been in any way prepared for the possible finding of this second aneurysm, there is really no reason to doubt that he might perhaps have succeeded in getting a clear picture of it in some other projection.

SUMMARY

The author briefly reviews the hitherto published cases of roentgenologically diagnosticated aneurysm of the heart, and concludes that aneurysms situated in the apex or in the wall of the diaphragm of the heart are considerably more difficult to thus diagnosticate than those situated in other parts of the organ. He then describes a case observed by himself, in which the aneurysm was both diagnosticated roentgenologically, and even correctly located to the apical region of the left chamber; but in which there also existed an aneurysm, situated higher up in the left chamber, which was *not* observed. In this instance it was, thus, the reverse that took place: the aneurysm in the apex was discovered, while the one higher up escaped observation.

ZUSAMMENFASSUNG

Verf. gibt über die publizierten Fälle von röntgenologisch diagnostiziertem Herzaneurysma einen kurzen Überblick, aus welchem man den Schluss ziehen muss, dass die an der Spitze oder der Zwerchfellfläche des Herzens lokalisierte Aneurysmen bedeutend schwerer zu diagnostizieren sind als die an den anderen Teilen des Herzens befindlichen. Er geht sodann zur Beschreibung eines von ihm selbst beobachteten Falles von Herzaneurysma über, das diagnostiziert und röntgenologisch im Spitzengebiet der linken Kammer lokalisiert wurde. Bei der später ausgeführten Autopsie erwiesen sich die Beobachtungen als richtig, man fand aber höher oben an der linken Kammer noch ein weiteres Aneurysma vor, das nicht beobachtet worden war. Es verhielt sich hier also umgekehrt: man diagnostizierte ein im Spitzengebiet lokalisiertes Aneurysma, während das höher oben gelegene der Beobachtung entgangen war.

RÉSUMÉ

L'auteur donne un court aperçu des cas publiés d'anévrysme du cœur radiologiquement diagnostiqués; on doit conclure de cet exposé que les anévrysmes localisés à la pointe ou à la face diaphragmatique du cœur sont notablement plus difficiles à diagnostiquer que ceux qui siègent dans une autre partie de l'organe. Il passe ensuite à la communication d'un cas personnel d'anévrysme cardiaque dont le diagnostic et la localisation à la pointe du ventricule gauche furent faits par la radiographie. L'autopsie ultérieurement pratiquée confirma ces observations,

mais permit de découvrir en outre un anévrysme passé inaperçu et situé plus haut dans le ventricule gauche. Il s'agit donc ici d'une circonstance inverse des circonstances habituelles: on fit le diagnostic d'un anévrysme de la pointe, tandis qu'un anévrysme siégeant plus haut échappa à l'observation.

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EINE METHODE, BEIM RÖNTGENPHOTOGRAPHIEREN DEN GRÖSSEREN TEIL DER SCHÄDLICHEN SEKUNDÄRSTRAHLUNG AUSZUSCHALTEN[1]*

von

Hugo Laurell

(Tabulæ LV—LVII.)

Wenn man in gewöhnlicher Weise mit Röntgen einen dicken Körperteil durchleuchtet und dabei trotz ziemlich starker primärer Abblendung infolge reichlicher Sekundärstrahlung ein kontrastloses und undeutliches Bild erhält, kann man die Qualität des Bildes merklich verbessern, indem man den Leuchtschirm einige Dezimeter von dem Gegenstand entfernt. Dies beruht darauf, dass hierbei ein grosser Teil der Sekundärstrahlung seitlich an dem Bildfeld vorbeigeht. Das Leuchtbild wird kontrastreicher und auch deutlicher, obgleich die Lichtstärke und die Schärfe des Bildes mit steigendem Abstand von dem Gegenstand abnehmen. Wenn man den Schirm nur ein paar Dezimeter entfernt und mit einer scharf zeichnenden Röhre arbeitet, nimmt doch die Unscharfheit nicht in störender Weise zu. Anders kann sich die Sachlage gestalten, wenn die Röhre einen grossen Fokus hat und wenn der Abstand zwischen Gegenstand und Schirm 3 dm wesentlich übersteigt. Alles dies dürfte von manchen Röntgenologen beobachtet worden sein; Durchleuchtung auf Abstand ist auch von dem einen und anderen Röntgenologen vorgenommen worden, vielleicht vor allem, wenn es sich darum handelte, die Herzpulsationen zu studieren, denn bei vergrössertem Schirmabstand werden der Herzschatten und seine Pulsationen grösser und deutlicher. Auch bei Durchleuchtung von Lungen und Verdauungskanal ist die Methode gelegentlich zur Anwendung gekommen.

Bedient man sich derselben Methodik beim Röntgenphotographieren, d. h. vergrössert man den Abstand zwischen dem Film und dem zu photographierenden Körperteil, so wächst der Kontrast des Bildes stark bei steigendem Abstand, doch nimmt dabei allerdings die Unscharfheit sukzessiv zu. Dieser letztere Nachteil dürfte manchen abgehalten haben,

[1] Vortrag im Schwedischen Verein für medizinische Radiologie am 28. 11. 1931.

* Bei der Redaktion am 28. XII. 1931 eingegangen.

diese Methodik ausser in Ausnahmefällen anzuwenden, wie z. B. beim Photographieren des untersten Hals- und obersten Brustwirbels in seitlicher Richtung; denn nur, wenn man die Kassette an oder neben die Schulter setzt, d. h. in einem Abstand von ca. 2 dm vom Halse, kann man den untersten Halswirbel und den obersten Rückenwirbel mit auf das Bild bekommen, und zwar am leichtesten bei aufrechter Stellung mit stark gesenkten Schultern (Gewichte in den Händen!). Vermutlich hat sich mancher ebenso wie der Verfasser über den relativ grossen Kontrast bei *so* aufgenommenen Bildern gewundert. Versuche, die Verf. in der letzten Zeit angestellt hat, haben ergeben, dass sich der Kontrast weiterhin wesentlich verbessert, wenn man den Abstand zwischen Gegenstand und Platte auf mehr als 2 dm erhöht. *Ja, schon bei 30—40 cm Abstand wird der grösste Teil der Sekundärstrahlung von dem Film ferngehalten*, vorausgesetzt dass das Bildfeld relativ klein ist: 15 × 20 cm oder weniger. Dies ist aus Fig. 1 ersichtlich, welche schematisch die Sekundärstrahlung zeigt, die von einem Punkt ziemlich tief in dem bestrahlten Gewebe ausgeht. F bezeichnet ein am Gegenstand liegendes Bildfeld und F^1 ein anderes in 40 cm Abstand. Die dicken Linien geben die Grenzen des primären Röntgenlichtbündels an. Da sich die Sekundärstrahlung nach allen Richtungen verbreitet, wird F^1 offenbar nur von einem sehr geringen Teil der Sekundärstrahlung getroffen, welche F trifft. Die Sekundärstrahlung nimmt jedoch nicht so stark wie mit dem Quadrat des Abstandes ab, wie Fig. 1 vermuten lassen könnte, denn die nach verschiedener Richtung ausgehenden Strahlen haben ein verschieden dickes Gewebe zu passieren,

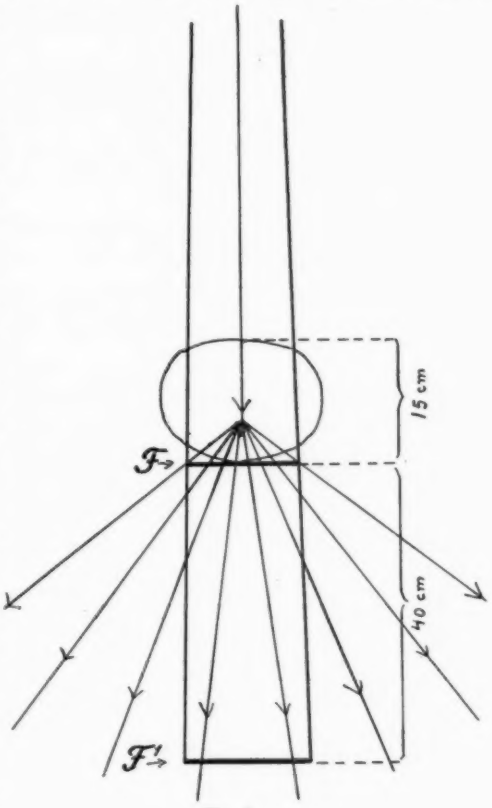

Fig. 1.

bevor sie das Bildfeld erreichen, und werden also in verschieden hohem Grad absorbiert. Ferner wächst nach dem sog. Compton-Effekt die Wellenlänge der Sekundärstrahlung bis zu gewissem Grade mit dem Streuwinkel.

Bei einem gegebenen Abstand zwischen Film, Gegenstand und Röntgenröhre wirkt diese Methode, die Sekundärstrahlung durch Streuung zu vermindern, um so günstiger, je stärker die primäre Abblendung, d. h. je kleiner das Bildfeld ist. Deshalb muss man die primäre Abblendung immer so stark wie möglich machen. Will man durch Streuung die Sekundärstrahlung bei einem grossen Bildfeld ebenso vermindern wie bei einem kleinen, so muss man im ersteren Fall einen grösseren Abstand zwischen Gegenstand und Film wählen als im letzteren.

Ein grosser Abstand zwischen Gegenstand und Film hat bekanntlich bei gewöhnlichem Röntgen-Photographieren gewisse Nachteile, vor allem Unscharfheit des Bildes und ausserdem eine verlängerte Exponierungszeit. Den ersteren Nachteil kann man ganz oder zum grösseren Teil ausschalten und in gewissen Fällen sogar überkompensieren, indem man teils den Abstand zwischen Röhre und Gegenstand stark vergrössert — auf 1.5—2 m oder mehr —, teils eine schmale Streckfokusröhre wählt, deren Fokus so auf den Film gerichtet wird, dass die Projektion des Fokus so klein wie möglich ausfällt. Glücklicherweise gewährt der lange Röhrenabstand eine bedeutend grössere Möglichkeit, eine kleine Fokusprojektion in allen Teilen des Bildfeldes zu erhalten. Offenbar wäre es ein Vorteil, wenn für das erwähnte Photographieren auf weiten Abstand besondere Röhren mit längerem und schmalerem Streckfokus konstruiert würden, als ihn die jetzt üblichen Röhren haben. Durch solche könnte die Bildschärfe weiterhin gesteigert werden.

Der stark erhöhte Abstand zwischen Röhre und Film würde unter Voraussetzung derselben Strahlung eine starke Verlängerung der Exponierung bedingen. *Glücklicherweise liefert die beschriebene Methode kontrastreiche Bilder auch mit einer sehr harten Strahlung*, ja selbst mit einer so harten, die bei gewöhnlicher Blendentechnik (mit Primär- oder Sekundärblende) sehr kontrastlose, verschleierte Bilder gibt. Durch Erhöhung der Spannung kann man deshalb bei den meisten Skelettphotographierungen trotz des langen Abstandes mit ziemlich kurzer Exponierungsdauer arbeiten, wenn man sich eines Verstärkungsschirmes bedient. So zeigt Fig. 2 eine Halswirbelsäule, aufgenommen von der Seite in 0.6 Sekunden mit 105 kV und 100 mA. Der Abstand zwischen Röhre und Hals betrug 1.65 m, zwischen Hals und Kassette 0.35 m. Fig. 3 zeigt die Processus spinosi der Brustwirbelsäule von der Seite, aufgenommen mit 100 kV in 1.5 Sek. Fig. 4 — Osteoperiostit an einem Unterschenkel — ist während 2 Sek. aufgenommen; 90 kV. Der Abstand zwischen Film und Gegenstand betrug 50 cm, der zwischen Röhre und Film 2.5 m.

Fig. 5 — Osteosarkom — ist während 4 Sek. aufgenommen; 90 kV und 100 mA. Auf Fig. 6 sieht man eine Schulter, 115 kV und 1 Sek.

Auf allen diesen Bildern sieht man, dass die Sekundärstrahlung gering ist; aber noch deutlicher tritt dies auf Übersichtsbildern von Kiefern mit plombierten Zähnen hervor, denn obgleich der Film 35 cm vom Gesicht entfernt ist, zeichnen sich die Schatten der Zahnplomben wasserklar ab.

Beim Photographieren wurde in den meisten Fällen eine gewöhnliche Schiebeblende mit Bleiplatten von 2 mm Dicke benutzt. Diese erwies sich jedoch im Laufe der Untersuchung als nicht voll effektiv bei der harten Strahlung, die beim Photographieren zur Anwendung kam: 90—115 kW. So sah man auf mehreren Bildern, z. B. Fig. 2, eine deutliche Schwärzung auch im Schatten der Blende (Bl.), und nur an den Stellen, wo ausser den Platten der Bleiblende dicke Gewebe die primäre Strahlung hemmten, blieb der Film ganz ungeschwärzt. Um die primäre Strahlung ganz abzublenden, mussten ca. 4 mm dicke Bleiplatten angewandt werden.

Hält man den grössten Teil der Sekundärstrahlung von dem Bilde fern, indem man den Abstand zwischen Film und Gegenstand gross genug wählt, so erhält man bei harter Strahlung — wenigstens bis zu 115 kW — und Verstärkungsschirm nicht nur kontrastreiche und in den Schatten klare Bilder, sondern diese sind auch harmonischer durchgezeichnet als gewöhnliche Röntgenbilder; denn die Überexponierung ausserhalb des Gegenstandes und innerhalb seiner Weichteile ist geringer als bei weicherer Strahlung. So sieht man die Weichteile oft bis an die Hautoberfläche und kann in ihnen Einzelheiten erkennen, die auf gewöhnlichen Skelettbildern oft nicht hervortreten. Man beachte z. B. auf Fig. 2 die Einzelheiten der Nackenmuskulatur und die Deutlichkeit der Luftsäule in Trachea und Rachen.[1]

Wenn man in gewöhnlicher Weise, mit der Kassette direkt am Gegenstand Röntgenaufnahmen macht, aber ebenso hohe Spannung (90—115 kW) benutzt wie in den oben abgebildeten Fällen, so erhält man ein verschleiertes Bild, auch wenn man eine Sekundärblende verwendet. Dies beruht nach Ansicht des Verf. von allem darauf, dass soche Blenden infolge ihrer Konstruktion (dünne, *niedrige* und oft parallele Bleilamellen mit Stützmasse zwischen diesen) nur einen relativ geringen Teil der reichlichen und intensiven Sekundärstrahlung hemmen, die von harter Primärstrahlung gebildet wird, und dass sie selbst sekundärstrahlen.

Meine Versuche haben gezeigt, dass — im Gegensatz zu der üblichen Ansicht — nicht in erster Linie die Qualität der Primärstrahlung bei gewöhnlicher Photographiertechnik, wenn harte Strahlung benutzt wird, an der Verschleierung und Kontrastlosigkeit des Bildes schuld ist, son-

[1] Leider sind die Reproduktionen nicht gelungen. Die Originalfilms zeigen eine viel zeichere Struktur sowohl im Skelette als in den Weichteilen.

dern dass diese Eigenschaften vor allem auf der harten Sekundärstrahlung beruhen. Hieraus kann man auch schliessen, dass, wenn man mit harter Strahlung arbeitet, die Sekundärblende einen anderen Bau haben muss als jetzt, um einigermassen effektiv zu sein. Bessere Wirkung haben die jetzt gebräuchlichen Sekundärblenden bei weicher Strahlung, denn die weiche Sekundärstrahlung, die von ersterer ausgelöst wird, kann effektiver von den dünnen und relativ niedrigen Bleilamellen abgeblendet werden. Ausserdem wird natürlich ein grösserer Prozentsatz dieser weichen Sekundärstrahlung im Gewebe absorbiert.

Auch bei einer so harten Strahlung, wie sie in der Therapie zur Anwendung kommt, kann man mit der neuen Methode, wenn nicht schöne, so doch durchaus brauchbare Bilder erhalten. Mit Stabilivoltapparat und einer Behandlungsröhre für Tiefentherapie (Elemas Fabrikat) wurden Bilder von nachstehendem Aussehen erhalten (Fig. 7). Mit Hilfe von zwei nahe beieinander sitzenden Bleiblenden wurde ein fokales Strahlenbündel von 6 mm Durchmesser durchgelassen, das durch ein Al-Filter von 1 mm Dicke filtriert worden war. Es wurden Bilder mit Verstärkungsschirm bei 7 m Abstand zwischen Röhre und Film und 70 cm zwischen Film und Gegenstand aufgenommen. kV 150, mA 6 und Exponierungsdauer 25 Sek. Wegen der Grösse des Fokus wurde der grosse Abstand von 7 m zwischen Röhre und Gegenstand gewählt, um die Unscharfheit zu kompensieren. Dieser grosse Abstand trug neben der niedrigen Milliampèrezahl zu der langen Exponierungsdauer bei. Bilder der gleichen Qualität, wie sie Fig. 7 zeigt, wurden auch bei so hoher kV-Zahl wie 170—190 erhalten. In allen Fällen wurde beim Photographieren ein 1 mm dickes Al-Filter benutzt. Bei diesen hohen kV-Zahlen war der Kontrastreichtum der Bilder jedoch merklich geringer als bei 90—115 kV.

Das Bemerkenswerteste der mit hohem kV (120—190) aufgenommenen Bilder scheint mir zu sein, dass die Luftschicht um den Gegenstand eine so geringe Schwärzung zeigt, obgleich das Bild im übrigen voll durchgezeichnet ist.

Die gemachten Photographierversuche mit gewöhnlichen für Tiefentherapie bestimmten Röhren zeigen, dass solche sehr wohl zum Nachweis einfacher Skelettschädigungen, z. B. Frakturen, benutzt werden können. Die Versuche haben auch ergeben, dass man während stattfindender Behandlung bei geeigneter Anordnung die Behandlungsröhre zum Photographieren verwenden kann, wobei man gleichzeitig zahlreiche Patienten photographieren und so einen Teil der Strahlung ausnutzen kann, die sonst verlorengeht. Man braucht nur eine Anzahl kleine Löcher in die Schutzkappe der Behandlungsröhre zu machen, von solcher Lage, Form und Grösse, dass die aus den Löchern dringenden fokalen Strahlenbündel gegen geeignet angebrachte und mit Bleiklappen versehene Luken in strahlendichten Wänden des Zimmers projiziert werden. Hinter diesen

Fig. 2.

Fig. 4.
2 Sek.

Fig. 5.

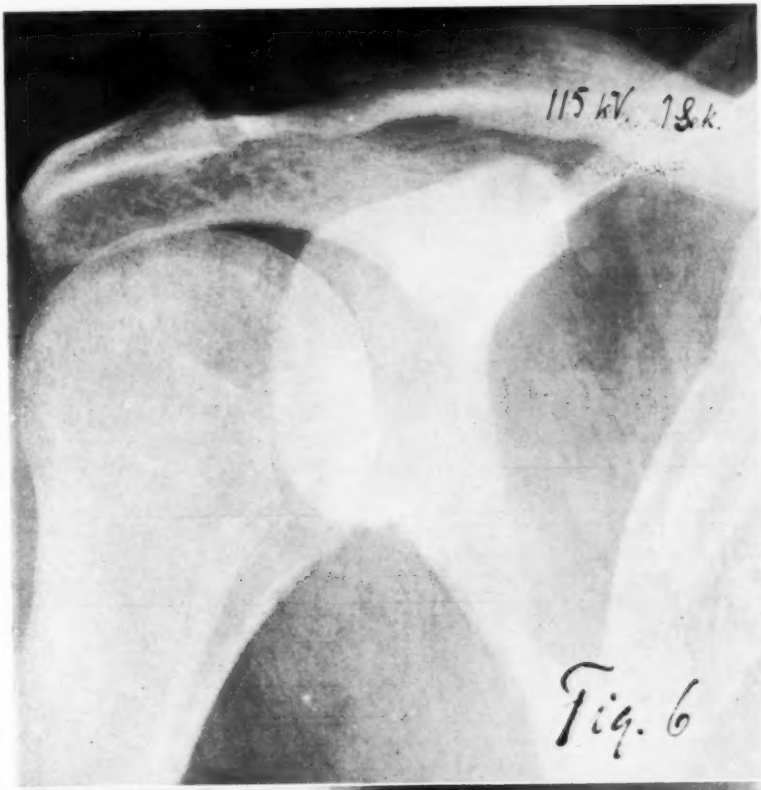

Fig. 6

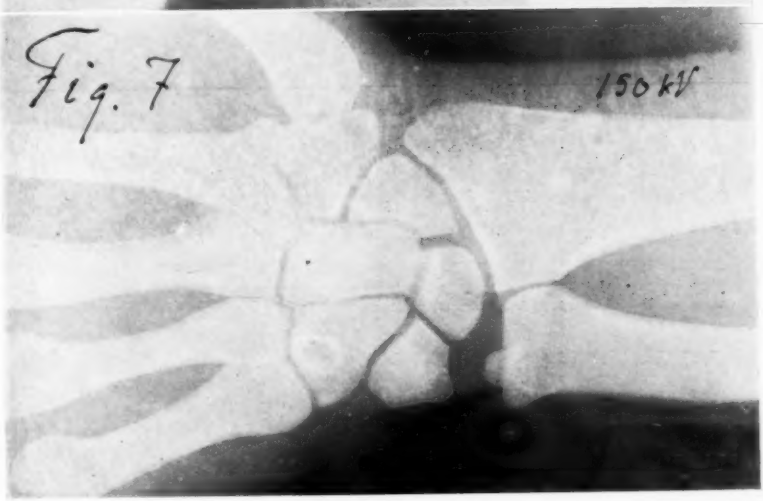

Fig. 7

Luken bringt man geeignete Ruhe- oder Fixationsvorrichtungen für verschiedene Körperteile an und $^1/_2$—1 m weiter entfernt innerhalb der bei offener Luke ausgehenden Fokalbündel geeignete Fixationsanordnungen für die Kassetten. Die Exponierung geschieht, nachdem Patient und Kassette in die nötige Lage gebracht sind, indem man die Luke öffnet und eine angemessene Zeit lang offen lässt.

ZUSAMMENFASSUNG

Verf. beschreibt eine Methode, mit harter Strahlung und ohne Buckyblende kontrastreiche und scharfe Bilder zu erhalten. Dies wird erreicht, indem man grosse, gut abgewogene Abstände zwischen Röntgenröhre, Gegenstand und Film wählt. Die Exponierungszeit ist infolge der harten Strahlung nicht besonders lang.

Man kann auch eine gewöhnliche Therapieröhre zum Photographieren benutzen und mit einer solchen während stattfindender Behandlung gleichzeitig eine grössere Anzahl Patienten photographieren.

SUMMARY

The author describes how to get radiographs, sharp and above all rich in contrast, with *hard* radiation and without Bucky-diaphragm. This is obtained by having long distances between the X-ray tube, the object and the X-ray film. The times of exposure are not particularly prolonged.

An ordinary tube for therapy can be used for radiographing too, and while the X-ray treatment is going on, it is possible to radiograph several patients at the same time and with the same tube.

RÉSUMÉ

L'auteur décrit une méthode d'obtenir des images radiologiques, riches en contraste et fortement marquées, en employant une radiation *bien dure* mais sans se servir du Bucky-diaphragme.

IIIe CONGRÈS INTERNATIONAL DE RADIOLOGIE, À PARIS; 26—31 JUILLET 1931

La plupart des Suédois qui ont assisté au IIIe Congrès International de Radiologie, réuni à Paris, du 26 au 31 juillet 1931, avaient collaboré, de façon ou d'autre, à la préparation du congrès précédent, tenu à Stockholm en 1928. Il est évident que nous envisagions avec beaucoup d'impatience et de curiosité le congrès de Paris, cette ville disposant de ressources infiniment plus riches que celles de Stockholm. Nous avons pu nous en rendre compte dès le début, au secrétariat du congrès tout d'abord et plus tard à l'occasion des fêtes auxquelles le congrès a donné lieu. Le secrétariat avait été admirablement organisé par le Dr. LEDOUX-LEBARD, secrétaire général, assisté des docteurs GIBERT et BÉCLÈRE, secrétaires, et, »last but non least», de l'infatigable M:elle ANTOINETTE BÉCLÈRE, la bonne fée du congrès.

La Sorbonne, où était installé le secrétariat et où se tenaient les séances scientifiques, nous a paru constituer le cadre idéal d'un congrès. Il y avait là, en effet, non seulement un grand nombre de salles de conférences, grandes ou petites, pour les six sections du congrès (radiodiagnostic, radiothérapie, radiophysique, radiobiologie, électrologie, héliothérapie); mais il s'y trouvait aussi le grand amphithéâtre, où a eu lieu la séance d'ouverture du congrès et où la plupart des 1,300 membres du congrès et des 500 membres adjoints se trouvaient fort à l'aise. Là, enfin, était aussi la grande et belle cour qui fut constamment utilisée comme lieu de rendez-vous et comme un lieu très approprié aux entretiens particuliers.

Le dimanche 26 juillet, fut ouverte l'exposition radiologique. Il avait malheureusement fallu l'installer dans le Palais des Congrès près de la Porte de Versailles, à une distance de près d'une demi heure de la Sorbonne. Toutefois, cette exposition, très soigneusement organisée par le Dr. BELOT, était fort importante et des plus intéressantes.

Le même jour les délégués se réunirent pour un déjeuner animé, à la Cité universitaire. A la séance qui suivit, on décida d'accepter l'invitation de la Suisse de tenir le prochain congrès à Zurich, en 1934. Le professeur SCHINZ fut élu président du congrès de Zurich.

On avait discuté dans des entretiens particuliers une proposition tendant à offrir à l'Allemagne le congrès de 1934, bien que la Société radiologique allemande n'eût pas cru devoir formuler une invitation. Cette proposition rencontra de vives sympathies et l'on regretta à l'unanimité que certaines difficultés de forme en rendissent impossible la réalisation.

Les séances scientifiques commencèrent le 27 juillet. Le même jour eut lieu la séance inaugurale du congrès, en présence notamment de M:me CURIE et de M. BLAISOT, ministre de l'hygiène. Le Président de la République, empêché d'assister à la séance inaugurale, avait l'amabilité d'offrir aux délégués une réception au palais de l'Elysée.

Le congrès fut ouvert par le professeur BÉCLÈRE, président, qui, dans son discours d'ouverture, fit un historique intéressant de l'évolution de la radiologie. Il souhaita ensuite la bienvenue aux trois délégués allemands, exprimant le regret que la crise économique eût empêché nos collègues allemands et autrichiens d'assister au congrès.

Le professeur BÉCLÈRE reçut de la délégation anglaise le diplôme de membre d'honneur de la Royal Society of Medicine; des radiologistes américains un maillet en ivoire, fait d'une dent de mammouth; de la Suisse le diplôme de membre d'honneur de l'université de Zurich. Le professeur FORSSELL lui remit en suite la chaîne, insigne de la présidence, et un maillet en ébène, artistement ouvragé, offert par les radiologistes suédois en souvenir du congrès international de radiologie de Stockholm.

Après cette cérémonie, le professeur FORSSELL, sur invitation spéciale, présenta un rapport sur »La lutte sociale contre le cancer». Ses paroles furent écoutées avec la plus grande attention. Il a dit notamment:

L'étude de la biologie et de la pathologie des maladies cancéreuses, ainsi que les recherches expérimentales, paraissent devoir être confiées aux institutions déjà existantes, tandis qu'il convient de charger des cliniques spécialement organisées pour le traitement des cancéreux et des laboratoires appartenant à ces cliniques, des travaux diagnostiques, cliniques et thérapeutiques.

Des deux principales méthodes de traitement du cancer: la méthode chirurgicale et la méthode radiologique, la première peut sauver environ 10 pour cent des cas. Les autres 90 pour cent ont besoin d'un autre traitement. Par la méthode radiologique, on peut obtenir une amélioration considérable de plus de la moitié des cas et, dans plus de 20 pour cent, une guérison primaire pour un temps plus ou moins long.

Etant donnée la grande importance de la radiothérapie, il faut que la société, dans la lutte contre les maladies cancéreuses, lui accorde une place équivalente à celle qu'elle a donnée autrefois à la chirurgie. La création de cliniques chirurgicales est un des plus grands gains qui aient

marqué cette lutte au 19e siècle. Dans la lutte sociale contre le cancer, la création de cliniques thérapeutiques devra être le grand apport de notre siècle. La radiothérapie doit être organisée de façon à former, dans chaque pays, un nombre suffisant d'établissements centraux bien équipés. Dans ces établissements centraux seront réunies les expériences faites dans les divers champs de la radiothérapie, ce qui sera de la plus haute importance pour les soins à donner aux malades et pour le développement de la radiothérapie elle-même.

Une clinique de 50 lits doit disposer d'environ 4 à 5 grammes de radium et d'un équipement complet d'appareils de Röntgen. A cette clinique doivent se rattacher des sections de radiophysique et de pathologie des tumeurs et une section spéciale ayant pour but de suivre les malades et surveiller les résultats du traitement.

La clinique radiothérapeutique doit être rattachée à un grand hôpital clinique. Il importe beaucoup de bien organiser la collaboration avec d'autres disciplines médicales, notamment avec la chirurgie. Le plus avantageux serait probablement de rattacher la clinique radiothérapeutique à un grand hôpital universitaire, en vue, d'une part, de l'appui que pourrait lui prêter les différentes institutions scientifiques de l'université et, de l'autre, de la formation des médecins qui désireraient se spécialiser dans la radiologie.

L'Etat et les communes doivent faciliter le traitement aux cancéreux indigents, en leur accordant la gratuité des voyages d'aller et retour pour se rendre à la clinique radiothérapeutique. La bienfaisance privée, en s'employant à fonder des maisons de santé et des asyles destinés aux malades chroniques, a un grand champs d'activité, où elle pourra faire beaucoup en s'efforçant de créer aux cancéreux inguérissables une existance aussi supportable que possible.

En plus des conférences annoncées et discutées par les différentes sections, il y a eu quatre conférences sur invitation spéciale, faites en séance plénière du congrès.

L. G. Cole, Etats-Unis, parla de l'exploration radiologique de la muqueuse du tube digestif.

Haenisch, Allemagne, étudia l'exploration radiologique de l'appareil urinaire par l'excrétion de substances opaques.

Lynham, Angleterre, analysa le traitement radiologique pré- et post-opératoire des cancers du sein.

Milani, Italie, traita de la röntgenthérapie des affections inflammatoires.

Le nombre des conférences annoncées dans les sections était de 400, mais ce chiffre subit une forte réduction par le fait que les conférences

allemandes et autrichiennes firent défaut. Inévitablement, leur absence causa quelque confusion dans le programme.

Dans la section radiothérapeutique, toute une journée fut consacrée au traitement du cancer du sein, thème qui fit l'objet de non moins de 14 conférences. WEBSTER présenta le matériel du Middlesex Hospital; PHALER exposa les résultats obtenus dans plus de mille cas traités par lui; LEE communiqua les résultats obtenus et les méthodes employées au Memorial Hospital etc. Il ressort des brèves analyses des conférences et des discussions qui les ont suivies, qu'il existe des divergences d'opinion très marquées sur le traitement du cancer du sein, et qu'il n'est pas encore possible, malgré les résultats extraordinaires présentés par quelques conférenciers, parmi d'autres PHALER, de procéder à une standardisation des différentes méthodes de traitement. Les résumés, ainsi que les conférences, n'étaient pas accompagnés de rapports d'hôpital suffisamment détaillés et contenant un nombre suffisant de faits, pour permettre un examen critique des résultats obtenus. Il sera donc indispensable d'attendre les publications complètes pour pouvoir porter un jugement sur les faits de cet ordre.

Parmi d'autres conférences remarquées de la section de radiothérapie, on peut relever celle de QUICK, du Memorial Hospital, sur le traitement des tumeurs de la bouche; celle de COUTARD sur la röntgenthérapie du cancer du larynx, par la méthode de COUTARD; et celle de MONOD sur les expériences faites dans le traitement du cancer du ventricle et de la vessie.

Le traitement du cancer de l'utérus et des maladies inflammatoires était le sujet principal des conférences de radiothérapie gynécologique. La question des adénocarcinoma et de leur prognose a suscité une discussion assez vive, et la conception française, exposée par M:me LABORDE et par d'autres, s'est fortement heurtée contre les expériences exposées par HEALY du Memorial Hospital, de New York, et par HEYMAN et REUTERWALL, du Radiumhemmet, de Stockholm.

Dans la section de radiophysique, la standardisation du dosage de Röntgen a fait le sujet de plusieurs conférences. La discussion a montré l'importance extraordinaire des travaux du congrès de Stockholm, pour la röntgenthérapie. Des informations intéressantes au sujet de la méthode et des instruments employés pour mesurer les rayons de radium et de Röntgen ont paru indiquer que nous nous approchons du jour où le médecin pourra déterminer, d'une façon sûre, la quantité de radiation qui vient agir sur chaque point de la partie du corps exposée aux rayons, et ceci non seulement dans des cas isolés et schématiques, comme cela s'est fait jusqu'ici, mais pour chaque malade soumis au traitement, ce qui permet d'affiner considérablement le dosage.

De même, on suivit avec beaucoup d'intérêt l'exposé des essais qui ont été faits dans le but d'utiliser pratiquement les rayons Röntgen, produits à une tension très haute, allant jusqu'à près d'un million de volts.

Dans la section radiobiologique, une quarantaine de conférences avaient été annoncée. Celles qui ont traité la question de l'efficacité biologique relative des rayons X et des rayons gamma, excitèrent le plus vif intérêt. Quatre conférenciers avaient abouti à des résultats entièrement différents, ce qui, au fond, n'est pas fait pour surprendre, puisque toute la question dépend de la difficulté qu'il y a de savoir s'il est possible, par l'emploi de méthodes de mesurage actuelles, d'exprimer dans une même unité, les quantités de rayons de Röntgen et de radium.

Il y eut pendant le congrès deux réunions de commissions, à savoir la commission internationale constituée à Londres, en 1926, dans le but d'élaborer des propositions pour établir des mesures de protection dans le travail avec les rayons Röntgen et de radium; et la commission pour l'établissement d'une unité internationale des rayons Röntgen. La première de ces commissions décida notamment de compléter les informations relatives à la protection contre les effets des rayons Röntgen très durs, pour lesquels on avait recommandé l'emploi de plomb de 15 millimètres au moins comme protection contre des rayons Röntgen, produits aux tensions de l'ordre de 400,000 volts.

Sur une proposition du membre suédois de la commission, on modifia certains détails de la protection prévue pour le dépôt du radium, les dispositions antérieures étant entièrement inutilisables pour les grandes quantités. Selon le règlement en vigueur jusqu'ici, une cuirasse de plomb de deux mètres et demi serait nécessaire pour un dépôt de 5 grammes de radium (quantité correspondant à peu près à celle que nous possédons aujourd'hui au Radiumhemmet). Le membre suédois proposa aussi que la question des mesures à prendre pour protéger le personnel et les médecins préposés au traitement à distance par de grandes quantités de radium, fut discutée par le prochain congrès. On décida de demander aux médecins et aux physiciens travaillant dans ce domaine, de faire connaître à cette occasion les expériences faites par eux.

En ce qui concerne la commission des unités Röntgen, elle accepta certaines propositions relatives aux règles de standardisation, et adopta un projet de modifications et d'additions en vue de rendre ces règles aussi appropriées que possible à la pratique du travail médical. Ensuite, on élut une sous-commission de sept membres,[1] chargée de préparer des propositions, d'une part en vue d'améliorer davantage encore l'unité Röntgen et les dispositifs techniques servant à la déterminer, et d'autre

[1] DE BROGLIE, FRIEDRICH, OWEN, PUGNO-VANONI, SIEVERT, SOLOMON, TAYLOR.

part en vue de déterminer une unité des rayons gamma. Le champ de travail de la commission s'étant étendu ainsi jusqu'à la curiethérapie, son nom fut changé en celui de »Commission internationale des unités radiologiques».

La longue série de fêtes commença par une soirée de réception, donnée, le 26 juillet, à l'Hôtel Continental. On dansa avec beaucoup d'entrain dans deux salles somptueuses, et toute cette fête fut empreinte de la gaîté la plus spontanée. Le 28, l'Opéra donna une brillante représentation de gala. Le coup d'œil de l'entrée de l'Opéra, renommée dans le monde entier, et des gardes municipaux qui, le sabre au clair, formaient la haie dans le bel escalier, l'assistance en grande tenue et la représentation nous laissèrent des impressions ineffaçables. Il en fut de même pour la fête de l'Exposition coloniale, avec ses zouaves paradant à l'entrée sur leurs chevaux blancs, ses curieuses danses d'indigènes sauvages et ses merveilleux effets de lumière. Les tables du banquet par sous scription qui avait lieu au Palais de la Mutualité, étaient au complet. A cette occasion, des représentants des différentes nations exprimèrent au Président et à ses collaborateurs les remerciements des invités. Les vifs applaudissements qui accompagnèrent ces allocutions, prouvèrent nettement combien les congressistes étaient sensibles à l'amabilité et à la cordialité extraordinaires dont ils avaient été l'objet de la part de leurs collègues français.

THE WORK OF THE INTERNATIONAL X-RAY UNIT COMMITTEE AND THE INTERNATIONAL X-RAY AND RADIUM PROTECTION COMMISSION DURING THE III INTERNATIONAL CONGRESS OF RADIOLOGY IN PARIS 1931

During the III International Congress of Radiology in Paris, July 1931, meetings were held by the »International X-Ray Unit Committee» and the »International X-Ray and Radium Protection Commission» which had been formed earlier on the initiative of British radiologists and physicists. The work of both these committees was marked by great interest on the part of all the members, and the recommendations adopted at the II International Congress of Radiology in Stockholm in 1928 were revised, which involved improvements as well as additions.

International X-Ray Unit Committee

After a revision of the earlier Recommendations of the Committee, the following proposal, in which alterations and additions to the Recommendations adopted by the Stockholm Congress are italicized, was submitted to the Executive Committee of the III International Congress. In some cases commentaries have been added in notes, containing the opinion of one of the Swedish members of the Committee on the various questions.

RECOMMENDATIONS OF THE INTERNATIONAL X-RAY UNIT COMMITTEE

The following recommendations are put forward by the undersigned members of the International X-ray Unit Committee for approval by the Executive Committee of the Third International Congress of Radiology:

1) The International Unit of X-radiation shall be the quantity which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in one cubic centimetre of atmospheric air at 0° C and 76 cm.

mercury pressure, such a degree of conductivity that one electrostatic unit of charge is measured at saturation current.

2) The International Unit of X-radiation shall be called the »Röntgen» and shall be designated by the letter 'r'.

3) *The »intensity» of the radiation shall be expressed in 'r' per minute or 'r' per second.*

4) Various standard methods shall be employed to establish the unit.

5) *All data given in Röntgen (r-units) shall be supplied with an index to distinguish between the incident dose which does not include the scattered radiation, and the effective dose which includes the scattered radiation.*

6) For all comparative purposes it is advisable to employ ionization chambers which have been calibrated in terms of a standard chamber for X-radiation of the various qualities employed. It is also advisable to make the wall effects of these chambers as small as possible.

7) The practical instrument used to measure X-ray output shall be called a dosage-meter (Dosismesser, dosimètre).

8) The constancy of the indications of the dosage meter shall be tested by means of gamma radiation emitted from a definite quantity of radium element, the measurement being carried out always under the same conditions.

9) Any specification of dosage is incomplete without specifying the quality as well as the quantity of the radiation. *For practical purposes it suffices to specify the quality of the X-radiation in terms of the half-value layer in copper when this value exceeds 0.1 m/m of copper, or in terms of the half value layer in aluminium for*

Ad. 3. This addition was made on the proposal of several members of the Committee[1]. The necessity of adopting a measure for the roentgen ray intensity is obvious. A statement of the »dosis» alone means that differences in radiation results caused by a possible time factor might easily be overlooked. It would have been better if from the first a unit of intensity had been selected instead of the dose-unite »r», called for instance Ir, when the dose would be expressed in Ir-minutes. The primary information — intensity and time — would then have been given a more logical and prominent place among the data determining a radiation treatment.

Ad. 5. By introducing this point, the Committee has attempted to remedy the former uncertainty and confusion in statements of doses given. The comparison between various methods of treatment described in the literature has been rendered difficult by certain authors not stating whether the effect of the scattered radiation from the body is included or not, and mistakes were therefore apt to be made. In dosing, the r-unit is in Sweden used practically exclusively in the sense »the incident dose». The committee might appropriately have proposed a definite index also, so that, for instance, r_i would mean »the incident dose» and r_e »the effective dose». The unit used in Sweden would thus be designated r_i.

Ad. 9. In the earlier Recommendations this point had only been worked in a general sense, and did not include any definite proposal as to how the quality of the radiation should be stated. For medical purposes it is now considered sufficient if the half-value layer and the maximum voltage are given. In Sweden, X-ray machines with kenotrons and condensers are now almost exclusively used, in which the quality of radiation is unambi-

[1] cf. inter alia SIEVERT, Acta Radiol. 122, p. 300, 1931.

radiation of less penetration. In all cases the value of the maximum voltage applied to the terminals of the tube shall be stated.

The specification of the dosage shall also include, in addition to intensity and quality, such factors as the intervals between the times of irradiation, size of field, etc.

The International X-Ray Unit Committee further recommends that:

1) The experimental method of establishing a standard for the determination of the International X-ray Unit shall be entrusted to a sub-committee consisting of the following members of the Unit Committee: M. de BROGLIE (France) W. FRIEDRICH (Germany), E. A. OWEN (Gt. Britain), R. SIEVERT (Sweden), I. SOLOMON (France), E. PUGNO-VANONI (Italy), L. S. TAYLOR (U.S.A.) (Honorary Secretary of the Committee, E. A. OWEN). This committee shall invite the collaboration of the various existing national bureaus for standard measurements and also those about to be instituted.

2) This committee shall consider (a) methods of controlling the constancy of dosage meters, (b) the correlation of X-ray and gamma-ray dosage, (c) the establishment of a gamma-ray unit of intensity.

3) The progress of the work done by the sub-committee shall be reported once a year to the members of the International X-ray Unit Committee.

4) Each country shall be requested immediately to elect their two representatives on the International X-ray Unit Committee; until new representatives are elected, the present members shall serve.

5) The international Committee shall henceforth be called »The International Committee for Radiological Units».

International X-Ray and Radium Protection Commission

After revision of the Recommendations adopted in Stockholm in 1928, these have been given the following wording, in which alterations and additions have been italicized here also and the comments of the Swedish member of the Committee have been added.

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guously determined, even if the maximum voltage and the filter alone are stated. This is probably one of the greatest advantages of this type of X-ray machine.

The last sentence of the paragraph is a request to the doctor to add to his statement of the dose as detailed information as possible regarding all data of importance to the treatment. The information given on this point, at least in the literature, is remarkably scanty. This may possibly be the main reason for the fact that different doctors, using »the same method of radiation», frequently obtain very divergent results of the treatment.

Ad. 1—5. The Committee does not consider its work concluded, but suggests a program for continued activity under a changed name, »The International Committee for Radiological Units». As appears from the proposed program of work for the next three years, the questions to be dealt with are chiefly those connected with the introduction of uniform dosage in radium therapeutics also. As regards the attitude of the Swedish members of the committee to these questions, we refer to an earlier article in this journal[1].

[1] SIEVERT loc. cit.

INTERNATIONAL RECOMMENDATIONS FOR X-RAY AND RADIUM PROTECTION

Revised by the International X-ray and Radium Protection Commission at the Third International Congress of Radiology, Paris, July 1931.

Members:

Dr. G. GROSSMANN, Germany.
Dr. R. LEDOUX-LEBARD, France.
Dr. R. SIEVERT, Sweden.
Dr. I. SOLOMON, France.
Dr. L. S. TAYLOR, United States.
Dr. E. PUGNO-VANONI, Italy.
Dr. G. W. C. KAYE, Great Britain } Hon.
Dr. S. MELVILLE, Great Britain } Secs.

International Recommendations

1. The dangers of over exposure to X-rays and radium can be avoided by the provision of adequate protection and suitable working conditions. It is the duty of those in charge of X-ray and radium departments to ensure such conditions for their personnel. The known effects to be guarded against are:

(a) Injuries to the superficial tissues;
(b) Derangements of internal organs and changes in the blood.

I. Working Hours etc.

2. The following working hours etc. are recommended for whole-time X-ray and radium workers.

(a) Not more than seven working hours a day.
(b) Not more than five working days a week. The off-days to be spent as much as possible out of doors.
(c) Not less than 4 weeks holiday a year, *preferably consecutively.*
(d) Whole-time workers in hospital X-ray and radium departments should not be called upon for other hospital service.
(e) *X-ray and particularly radium workers should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general and blood examinations. These examinations will determine the acceptance, refusal, limitation or termination of such occupation.*

II. General X-Ray Recommendations

3. X-ray departments should not be situated below ground floor level.

4. All rooms, including dark rooms, should be provided with windows affording good natural lighting and ready facilities for admitting sunshine and fresh air whenever possible.

5. All rooms should be provided with adequate exhaust ventilation capable of renewing the air of the room not less than 10 times an hour. Air inlets and outlets should be arranged to afford cross-wise ventilation of the room.

Ad. 2 (e). One inevitably wonders in how many radiological clinics such continuous control of the state of health has really been accomplished! The systematic introduction of such a safeguard in all hospitals where radiological work is done would be highly desirable.

6. All rooms should preferably be decorated in light colours.

7. A working temperature of about 18° C. (65° F.) is desirable in X-ray rooms.

8. X-ray rooms should be large enough to permit a convenient lay-out of the equipment. A minimum floor area of 250 sq. ft. (25 sq. metres) is recommended for X-ray rooms and 100 sq. ft. (10 sq. metres) for dark rooms. Ceilings should be not less than 11 ft. (3.5 metres) high.

9. Wherever practicable the X-ray generating apparatus should be placed in a separate room from the X-ray tube.

III. X-Ray Protective Recommendations

10. An X-ray operator should on no account expose himself unnecessarily to a direct beam of X-rays.

11. An operator should place himself as remote as practicable from the X-ray tube.

12. The X-ray tube should be surrounded as completely as possible with protective material of adequate lead equivalent.

13. The following lead equivalents are recommended *under average conditions:*

X-rays generated by peak voltages	Minimum equivalent thickness of lead
Not exceeding . . . . . 75 k.V.	1 mm.
» » . . . . . 100 »	1.5 »
» » . . . . . 125 »	2 »
» » . . . . . 150 »	2.5 »
» » . . . . . 175 »	3 »
» » . . . . . 200 »	3 »
» » . . . . . *250* »	*6* »
» » . . . . . *300* »	*9* »
» » . . . . . *350* »	*12* »
» » . . . . . *400* »	*15* »

14. In the case of diagnostic work, the operator should be afforded protection from scattered rays by a screen of a minimum lead equivalent of 1 mm.

Ad. 11. The following sentence has been excluded from this point: »It should not be possible for a well rested eye of normal acuity to detect in the dark appreciable fluorescence of a screen placed in the permanent position of the operator.» This is because experience has proved that under certain conditions and with certain fluoroscopic screens a noticeable fluorescence does not necessarily mean that the radiation intensity is too large. Neither is it suitable that so subjective a method of examining the protection should in any way be recommended.

Ad. 13. For the previous »as adequate» has been substituted »under average conditions». Circumstances are quite conceivable where the recommended minimum protection is not enough or else unnecessarily large. In any case it will be the local conditions, and not least the thickness of the protective walls (see para. 15), that must decide whether deviations from the table of para. 13 can be justified or not.

15. In the case of X-ray treatment the operator is best stationed completely outside the X-ray room behind a protective wall of a minimum lead equivalent of 2 mm. This figure should be correspondingly increased if the protective value of the X-ray tube enclosure falls short of the values given in paragraph 13. In such event the remaining walls, floor and ceiling may also be required to provide supplementary protection for adjacent occupants to an extent depending on the circumstances.

16. Screening examinations should be conducted as rapidly as possible with minimum intensities and apertures. *Palpation with the hand should be reduced to the minimum.*

17. The lead glass of fluorescent screens should have the protective values recommended in paragraph 13.

18. In the case of screening stands the fluorescent screen should, if necessary, be provided with a protective »surround» so that adequate protection against direct radiation is afforded for all positions of the screen and diaphragm.

19. Screening stands and couches should provide adequate arrangements for protecting the operator against scattered radiation from the patient.

20. Inspection windows in screens and walls should have protective lead values equivalent to that of the surrounding screen or wall.

21. Efficient safeguards should be adopted to avoid the omission of a metal filter in X-ray treatment.

22. Protective gloves, which should be suitably lined with fabric or other material, should have a protective value not less than $^1/_2$ mm lead throughout both back and front (including fingers and wrist). Protective aprons should have a minimum lead value of $^1/_2$ mm.

IV. Electrical Precautions in X-Ray Rooms

23. The floor-covering of the X-ray room should be of insulating material such as wood, rubber or linoleum.

24. Overhead conductors should be not less than 9 ft. (3 metres) from the floor. They should consist of stout metal tubing or other coronaless type of conductor. The associated connecting leads should be of coronaless wire kept taut by suitable rheophores.

25. Wherever possible earthed guards *or earthed sheaths* should be provided to shield the more adjacent parts of the high tension system. *The use of X-ray*

Ad. 16. The addition in this paragraph will be considered an obvious one by all radiologists. With the generally well developed protection of today, palpation will be one of the few occasions, not to say the only one, where the radiologist is exposed to direct X-ray radiation.

Ad. 22. The earlier figure, $^1/_2$ mm of lead, has been changed to $^1/_3$ mm., as there seem to be no suitable gloves in the market giving better protection.

Ad. 25. As regards the recommendations of the use of X-ray equipments having the high tension circuits completely enclosed in earthed sheaths it may be pointed out that, apart from reducing the danger of touching the high voltage lines, another advantage is also gained by these arrangements. The poisonous gases arising chiefly from corona effects and sparking are not given an opportunity to foul the air in the treatment room.

equipment having the high tension circuit completely enclosed in earthed conductors is specially recommended. Unless there are reasons to the contrary, metal parts of the apparatus and room should be efficiently earthed.

26. The use of quick acting double-pole circuit breakers is recommended. Overpowered fuses should not be used. If more than one apparatus is operated from a common generator, suitable overhead multi-way switches should be provided.

27. Some suitable form of kilovoltmeter should be provided to afford a measure of the voltage operating the X-ray tube.

28. *Special electrical precautions should be taken in rooms where anaesthetics are used in conjunction with X-rays.*

V. Film Storage Precautions

29. *The use of non-inflammable X-ray films should be encouraged. In the case of inflammable films, suitable precautions should be taken as regards their use and storage. Large stocks should be kept in isolated stores, preferably in a separate building or on the roof.*

VI. Radium Protective Recommendations

A) Radium Salts

30. Protection for radium workers is required from the effects of:

(a) Beta rays upon the hands;

(b) Gamma rays upon the internal organs, vascular and reproductive systems.

31. In order to protect the hands from beta rays, reliance should be placed, in the first place, on distance. The radium should be manipulated with long-handled forceps, and should be carried from place to place in long-handled boxes, lined on all sides with at least 1 cm. of lead. All manipulations should be carried out as rapidly as possible.

32. Radium, when not in use, should be stored in a safe as distant as possible from the personnel. It is recommended that radium tubes or applicators be inserted

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Ad. 28 and 29. These paragraphs did not exist in the earlier Recommendations, but will need no justification.

Ad. 31. In the corresponding previous paragraph it was pointed out that the forceps should be »preferably made of wood». As the secondary beta-radiation is largest in materils of low and high atomic weight, but reaches a minimum for the materials Ni, Fe, Cu, and Zn, there is no reason why wood should be used.

Ad. 32. The rules regarding lead protection when storing radium have been changed so that if the stipulations of the table are followed, the radiation penetrating will be of the same magnitude, irrespective of the radium quantity. The protection given by the lead thicknesses recommended is more than ample as regards risks to the staff. It is, however, generally of great importance that attention be given also to such radiation measurements as may conceivably be made in connection with radiological treatment, and the gamma rays should therefore be effectively screened off.

into separate lead blocks in the safe, giving a thickness of protective wall amounting to *the values given in the following table:*

Maximum quantity of radium element	*Thickness of lead*
0.2 gm.	*8.5 cm.*
0.5 »	*10* »
1.0 »	*11.5* »
2.0 »	*13* »
5.0 »	*15* »
10.0 »	*17* »

33. A separate room should be provided for the »make-up» of screened tubes and applicators, and this room should only be occupied during such work.

34. In order to protect the body from the penetrating gamma rays during handling of the radium, a screen of not less than 2.5 cm of lead should be used, and proximity to the radium should only occur during actual work and for as short a time as possible.

35. The measurement room should be a separate room and it should *preferably* contain the radium only during its actual measurement.

36. Nurses and attendants should not remain in the same room as patients undergoing radium treatment *with quantities exceeding* $^1/_2$ *gm.*

37. All unskilled work or work which can be learnt in a short period of time should preferably be carried out by temporary workers, who should be engaged on such work for periods not exceeding 6 months. This applies especially to nurses and those engaged in »making-up» applicators.

38. Discretion should be exercised in transmitting radium salts by post. In the case of small quantities it is recommended that the container should be lined throughout with lead not less than 5 cm thick. It is more satisfactory to transport large quantities by hand in a suitably designed carrying case.

B) Emanation

39. In the manipulation of emanation, protection against the beta and gamma rays has likewise to be provided.

40. The handling of emanation should be carried out, as far as possible, during its relatively inactive state.

41. The escape of emanation should be very carefully guarded against, and the room in which it is prepared should be provided with an exhaust fan.

Ad. 36. The italicized addition has been introduced for the reason that the rule should be applicable principally in treatments with large radium quantities, e. g. in distance treatments.

Possibly an addition ought to have been made to this, for instance »or remain at a distance less than 2 metres from patients undergoing treatment with quantities of radium smaller than $^1/_2$ gr.» Perhaps a rider should also be added referring to the fact that distance is the best protection against radium.

42. Where emanation is likely to come in direct contact with the fingers, thin rubber gloves should be worn to avoid contamination of the hands with active deposit. Otherwise, the protective measure recommended for radium salts should be carried out.

43. *The pumping room should preferably be contained in a separate building.* The room should be provided with a connecting tube from the special room in which the radium is stored in solution. The radium in solution should be heavily screened to protect people working in adjacent rooms. This is preferably done by placing the radium in solution in a lead lined box; the thickness of lead recommended being according to the table in paragraph 32.

Beside revising the Recommendations of the X-ray and Radium Protection Commission, the Committee resolved to collect information, before the next congress, from those radiologists who work with teleradium treatment with radium regarding their experiences of the risks and the need of protection in this method of treatment.

The present rapid development of X-ray Curie therapeutics is reflected in the alterations and additions indicated in the above report on the work of the two Committees. The Recommendations of the two Committees will in all probability require to be revised or supplemented again, even at the next International Congress of Radiology.

These International Recommendations obviously cannot in every respect be the rule and guide of radiological work in the several countries. Nevertheless they provide a firm foundation to build on, which is of importance not least when proposals have to be made for legislation to regulate work with X-rays and radium rays. In any case, they lead to cooperation and a valuable exchange of ideas among some of the radiologists of the various countries, and so contribute, not inconsiderably, to increased interest in the International Congresses of Radiology.

Ad. 43. In earlier Recommendations the necessity was pointed out that a separate room for pumping emanation should be used. In view of the risks arising from diffusion of emanation to adjacent premises, it has been recommended that the pumping plant should if possible be placed in a separate building. This is also suitable in view of the difficulty of making radiation measurements in a building where even very small quantities of emanation are present in the air.

MAILLET PRÉSIDENTIEL OFFERT AUX CONGRÈS INTERNATIONAUX DE RADIOLOGIE

par

la Société Suédoise de Radiologie Médicale

A la séance inaugurale du III:e Congrès International de Radiologie le Prof. GÖSTA FORSSELL, au nom de la *Société Suédoise de Radiologie Médicale*, a remis un maillet présidentiel au Président du Congrès, M. le Dr ANTOINE BÉCLÈRE.

Le maillet est en ébène et argent sterling. La manche a la forme d'un tube de roentgen de type moderne. A la place de l'obturateur se trouve une plaque cylindrique avec le monogramme des Congrès Internationaux de Radiologie, *C. R. I.* Sur la bande en argent entourant l'attache de la manche est gravé les armes de la Suède, Trois Couronnes.

et sur la plaque en argent terminant la manche: *Dederunt socii suecani.* La tête du maillet est ornée de symboles des rayons du soleil et du rayonnement du radium. Les rayons émanant d'un soleil à la partie antérieure de la tête forment une large ceinture autour de celle-ci. Au sommet de la tête est placé un diamant répandant une couronne de rayons sur la partie sphérique du maillet. La manche renferme un bâton en argent que l'on peut dévisser avec l'extrémité de la manche où il est attaché. Sur ce bâton est gravé, et le nom latin du Congrès, *Conventus Radiologorum Internationalis* et les noms des villes — *Londres, Stockholm, Paris,* — ayant été jusqu'ici les sièges des congrès, ainsi que les années de ces congrès. Place est réservée aux noms des futurs sièges pendant un siècle.

Le maillet est dessiné par le Baron ERIK FLEMING et exécuté à l'*Atelier Borgila, Stockholm.*

En offrant le maillet le Prof. FORSSELL a prononcé l'allocution suivante:

Tant que les insignes présidentiels m'autorisent encore à parler devant vous en représentant du Deuxième Congrès International de Radiologie, je me permets, aux noms des radiologistes suédois, de vous offrir, à vous M. le Dr. BÉCLÈRE et aux futurs Présidents des Congrès Internationaux de Radiologie, un humble cadeau en souvenir du Congrès de Stockholm. M. le Président, ne soyez pas surpris quand je vous dis, que notre cadeau — comme celui des collègues américains — a pris la forme d'un maillet présidentiel. A un auditoire romain, ce signe de la dignité présidentielle paraît peut-être étrange. Mais dans les pays scandinaves le maillet est un attribut qui revient au président d'une assemblée.

Pour vous faire mieux comprendre notre prédilection pour le maillet comme symbole du pouvoir présidentiel, je vais vous raconter en quelques mots la légende du marteau. D'après la légende, le marteau est d'origine divine. Il est l'arme de Thor, dieu de la foudre, et constitue la source première supposée de l'électricité. En effet, la légende raconte que le dieu Thor par son marteau a abattu les géants menaçant l'humanité et qu'aux coups de son marteau naquirent les éclairs au ciel. Un marteau serait donc bien à sa place entre les mains du président d'un Congrès de Radiologie. Mais à la main d'un président, le marteau a une mission plus paisible à remplir, la même que la sonnette présidentielle, celle de détourner l'électricité s'accumulant dans une assemblée délibérante et de sanctionner les résolutions prises.

Le maillet que je vous offre porte les symboles des armes de la radiologie. La manche a la forme d'un tube moderne de roentgen et la tête est ornée de rayons en argent symbolisant les rayons vivifiants du soleil et les rayons salutaires de Becquerel.

Le maillet porte deux marques de naissances. Les armes fort anciennes de la Suède, Trois Couronnes, indiquent son lieu de naissance, et un

diamant formant le centre des rayons de la tête veut rendre hommage à la Ville Lumière, la ville où s'est fait la découverte du radium et d'où est originaire la curiethérapie.

Monsieur le Docteur BÉCLÈRE, nous sommes convaincus qu'à votre main, le maillet présidentiel saura produire le feu sacré qui nous est nécessaire pour atteindre les buts élevés de notre science et qu'il formera aussi un bâton de commandement dans la lutte contre les géants que nous avons à combattre, la maladie et la souffrance.